APPENDIX A

Geology and Groundwater Resources, Soils and Topography

APPENDIX B

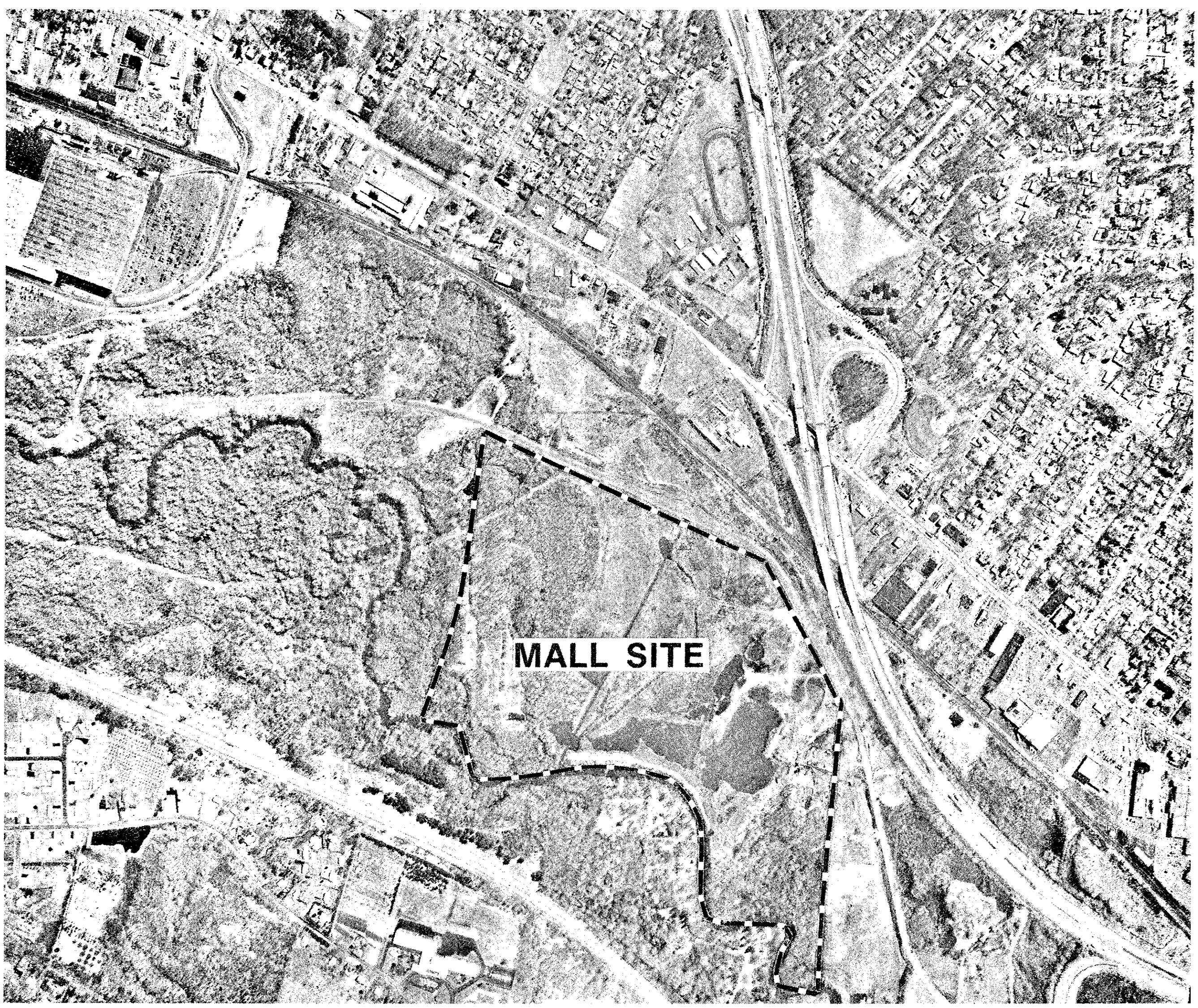
Vegetation, Wildlife and Wetlands

APPENDIX C

Surface Water Resources and Water Quality

NORTH HAVEN MALL

NORTH HAVEN, CONNECTICUT



1981

US Army Corps of Engineers

New England Division

A

Appendix A

Geology and Groundwater Resources; and Soils and Topography

The material contained in this appendix was prepared for Mall Properties, Inc., by Jason M. Cortell and Associates, Inc. It has been provided to the Corps of Engineers as information in support of application #13-79-561 for a permit under Section 404 of the Clean Water Act of 1977, and Section 10 of the River and Harbor Act of 1899.

GEOLOGY and GROUNDWATER RESOURCES
SOILS and TOPOGRAPHY

APPENDIX A

NORTH HAVEN MALL
North Haven, Connecticut

Prepared for:

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New York, New York

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July, 1981

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1.0 INTRODUCTION

1.1 Regional Geology and Topography

The Connecticut valley is a 90-mile long north-south trending topographic lowland bordered by the Eastern and Western Highlands. The proposed North Haven Mall site is located in the narrower western Quinnipiac-Farmington Lowland. The valley is underlain by Triassic sediments while the highlands are formed of crystalline igneous and metamorphic rocks (Krynine, 1937). A longitudinal ridge of basalt forms the base for the Eastern Highlands which partially divide the valley into two unequal parts. The eastern valley is drained by the Connecticut River while the Quinnipiac drains the western portion.

The prominent relief features of the region are based upon Triassic bedrock formations which were later worked by glaciers. As Porter (1960) points out, local topography is controlled by both bedrock distribution and glacial deposits. In upland areas, glacial sediments are thin and conform to bedrock forms while in the valleys, thick stratified drift deposits form those features classically considered glacial.

The Triassic sedimentary bedrock of the area consists of conglomerate, arkosic siltstones and sandstones with a high feldspar content, and shales (Porter, 1960). These are inter-stratified with basaltic dykes and sills which constitute the local igneous bedrock units. During the late Triassic Age, extensive deposition of continental sediments took place. At three separate times during this deposition, lava flows covered the surface and these were, in turn, buried by more sediments from the east. During this period, dykes and other intrusive bodies were emplaced. At the end of the Triassic Age, the sedimentary trough was tilted to the east and normal faulting occurred, displacing the sedimentary and igneous units. During the Cenozoic, slow uplifts took place, accompanied by the differential erosion of the bedrock by streams. Valleys developed in the softer sedimentary rocks and by the early Pleistocene, surface features and drainage patterns were similar to those which exist at present.

1.2 Regional Bedrock Geology

In general, high topographic relief coincides with bedrock outcrops. In the valley, however, bedrock was covered with glacial deposits. Thus, topography in the lowlands is the result of glacial working and is less reflective of bedrock configuration. Most of the area is underlain by sandstone and siltstone. These are interstratified by three basaltic lava flows which, with related basaltic dykes and sills, constitute the igneous bedrock units. Most of the area is underlain by the pinkish-grey New Haven arkose. The New Haven arkose is high feldspar sandstone and conglomerate with interbedded layers of red siltstone. They are variably and irregularly stratified striking northeast and dipping southeast at angles between 10° and 20°. To the northeast, Talcott basalt is present and Totoket Mountain is formed by Holyoke basalt overlying the Shuttle Meadow formation. Mount Carmel is a basaltic intrusion.

1.3 Regional Surficial Geology

According to Porter (1960), the surface deposits of the area are of glacial origin. A variety of these Pleistocene sediments are distributed throughout the locale. These and the bedrock have been additionally worked by water during the post-glacial period. Thus, a mixture of glacial and alluvial sediments are characteristic of the region.

There is evidence of glacial erosion on bedrock outcrops. The striations left by rocks moved by the glacier suggest that pre-existing bedrock topography locally influenced ice movement. Well records show that the bedrock floor of the Quinnipiac Valley lies below sea level and in some places the thickness of glacial drift exceeds 200 feet (Porter, 1960). The irregular gradient of the bedrock valley suggests that glacial and post-glacial erosion were important factors in deepening the valley.

There are two major categories of glacial deposit: sediments transported by ice and those transported by water. Ice-transported sediments consist of till or unsorted, non-stratified sediments deposited by the glacier ice. Water-transported sediments consist of sorted, stratified material laid down by meltwater.

Till forms continuous cover on the upland surfaces but on the valley floors it is usually buried beneath alluvial sediments. The till is stony; the coarse fractions are derived from the basalt ridges, the finer fractions are derived from the sandstone, siltstone, shale, and conglomerate bedrocks. Till thickness is variable, generally being thinnest along the tops of hills but thickening downhill to as much as 40 feet. Around North Haven, the thickness of till ranges from 0 to 30 ft (Porter, 1960). The till is reddish-brown, reflecting the bedrock source.

Ice-contact stratified drift is found along the Muddy River valley and in isolated areas along the Quinnipiac River. The ice-contact stratified drift is reddish in color. Ice-transported material constitutes approximately one-third of the sediment while the remainder is reworked local bedrock.

Laminated and non-laminated clay and silt occur at several localities in the Quinnipiac Valley. The New Haven clay, which shows regular lamination, underlies much of the valley, reaching thicknesses of 160 ft (Porter, 1960). The eastern edge of the Quinnipiac River Valley is lined with yellowish grey outwash built up by meltwater when the ice margin lay well to the north. This overlying outwash is a thin surficial deposit with a maximum recorded thickness of 32 feet. The outwash was derived from crystalline rocks in the Farmington and Pequabuck drainage basins, but has been mixed with locally-derived Triassic material (Krynine, 1937).

The post-glacial deposits consist of terrace alluvium, alluvium, swamp deposits, eolian sediment, and artificial fill.

The Quinnipiac River is bordered by terrace alluvium ranging in thickness from 0 to 5 feet (Porter, 1960). The brown to yellow sediment is poorly to well-sorted and consists of a variable mixture of local Triassic materials, and igneous rocks from the western upland. The distribution of the sediment suggests local derivation and riverine deposition during the post-glacial period.

Well-sorted sand and silt alluvial sediments are confined to the river and flood plain of the Quinnipiac. In the river channel, there is a pebble and cobble bed. This alluvium differs from the terrace alluvium in having a lower crystalline content and a reddish color.

Swamp deposits are found scattered throughout the region. They consist primarily of dark brown muck with a high organic content (Porter, 1960). Although swamp deposits are typically associated with wetlands, not all wetlands are underlain by this material.

A thin eolian deposit occurs throughout the area but delineation of the deposit is difficult due to its incorporation into the soil forming processes.

Artificial fill is found along roads and railroads and in some areas constitutes the bulk of the sediment. In most cases, it has been obtained from nearby sand and gravel deposits. Along the railway lines, crushed Holyoke basalt has been used.

1.4 Regional Soils

The project area has two main soil types, both closely related to the parent bedrock. They are till soils and stratified drift soils. The till soils are stony and poor for farming. The North Haven area is dominated by the Penwood-Manchester-Deerfield association formed mainly of material weathered from Triassic sandstone and conglomerate (Reynolds, 1979). This soil association consists of well-drained sandy soils on broad outwash plains. According to the Soil Conservation Service (SCS), septic systems in these soils have the potential to pollute groundwater. They have good potential for community development, but because of the rapid drainage are not recommended for farming.

1.5 Regional Groundwater Resources

Regional sources of groundwater primarily include those areas where surficial deposits, especially stratified drift, occur. The location of stratified drift generally defines the extent of the aquifer. According to Mazzaferro et al. (1979), stratified drift deposits associated with the Quinnipiac River Valley extend from New Haven to Meriden and then from Cheshire to Plainville. However, other regional aquifers are located throughout the Quinnipiac River Basin. These occur primarily along the Mill River and its tributaries from New Haven to Bristol and the Farm River from East Haven to North Branford.

Expected yields vary with the coarseness of the stratified material from 20 - 2,000 gpm (Mazzaferro et al., 1979). The largest well yields are generally obtained from coarse-grained stratified drift deposits near major streams. For the most part, the groundwater quality in the Quinnipiac River valley is good and reflects the chemistry of the underlying bedrock. Concentrations of iron, manganese, chlorides, and nitrates are generally low. The hardness of the water is variable. In relation to other surficial material, stratified drift deposits are relatively susceptible to contamination as they may be recharged by precipitation directly, from adjacent upland areas, and from the induced infiltration of water from streams and lakes. The susceptibility of these deposits to contamination may also be attributed to their increased porosity and coefficient of permeability, for example, relative to other surficial material (See Mazzaferro et al., 1979 for a discussion of groundwater resources in the Quinnipiac River Basin).

2.0 ENVIRONMENTAL SETTING

2.1 Project Site

2.1.1 Topography

The topography of the project site has changed substantially over the past three to four decades. In 1971 the Town of North Haven constructed the Valley Service Road adjacent to the Quinnipiac River in order to make the area in which the Mall is to be situated accessible to and more suitable for industrial and related uses. That road is adjacent to the Pratt-Whitney Aircraft engine plant, an early industrial development in the Quinnipiac River Valley of North Haven.

In the early 1970's, the State of Connecticut reconstructed Route 22 to serve as a high-speed connector between Interstate 91 to the east and the Wilbur Cross Parkway to the west. This reconstruction greatly facilitated vehicular accessibility to the site area.

The site, until recently, has been used for quarrying and mining operations, which were carried out on the property for over twenty years. The processing of sand and gravel continues to occcur on the project site. The quarrying operation resulted in the creation of four ponds, totaling approximately 10 acres, and adjacent low-lying areas, on the southern part of the site. Substantial portions of the northern section of the site were used as a "borrow pit" in the mid-1960's for the construction of Interstate 91, causing the creation of man-made lowlands in that portion of the site. Additional topographic modifications on the project site resulted from the construction of a drainage channel by the Connecticut Department of Transportation (DOT). This channel traverses the site in an east-west direction and extends from Valley Service Road to the Quinnipiac River.

Various sources reflect the site's long history of earth disturbing activities. A 1943 U.S. Geological Survey (USGS) topographic map showed surface elevations within the site ranging from +20 to +60 ft mean sea level (MSL). A 1956 topographic map entitled "Relocation of U.S. 5" showed a wide range of surface elevations, all generally lower than those which existed previously. At this time (1956), the northern portion of the site was essentially flat, averaging +17 ft MSL. The central portion of the site showed considerable variation, ranging from +20 to +52 ft MSL. A major depression with elevations ranging from +8 to +11 ft MSL appeared in the area now occupied by Pond 1. The southernmost part of the site showed surface elevations of +25 to +43 ft MSL.

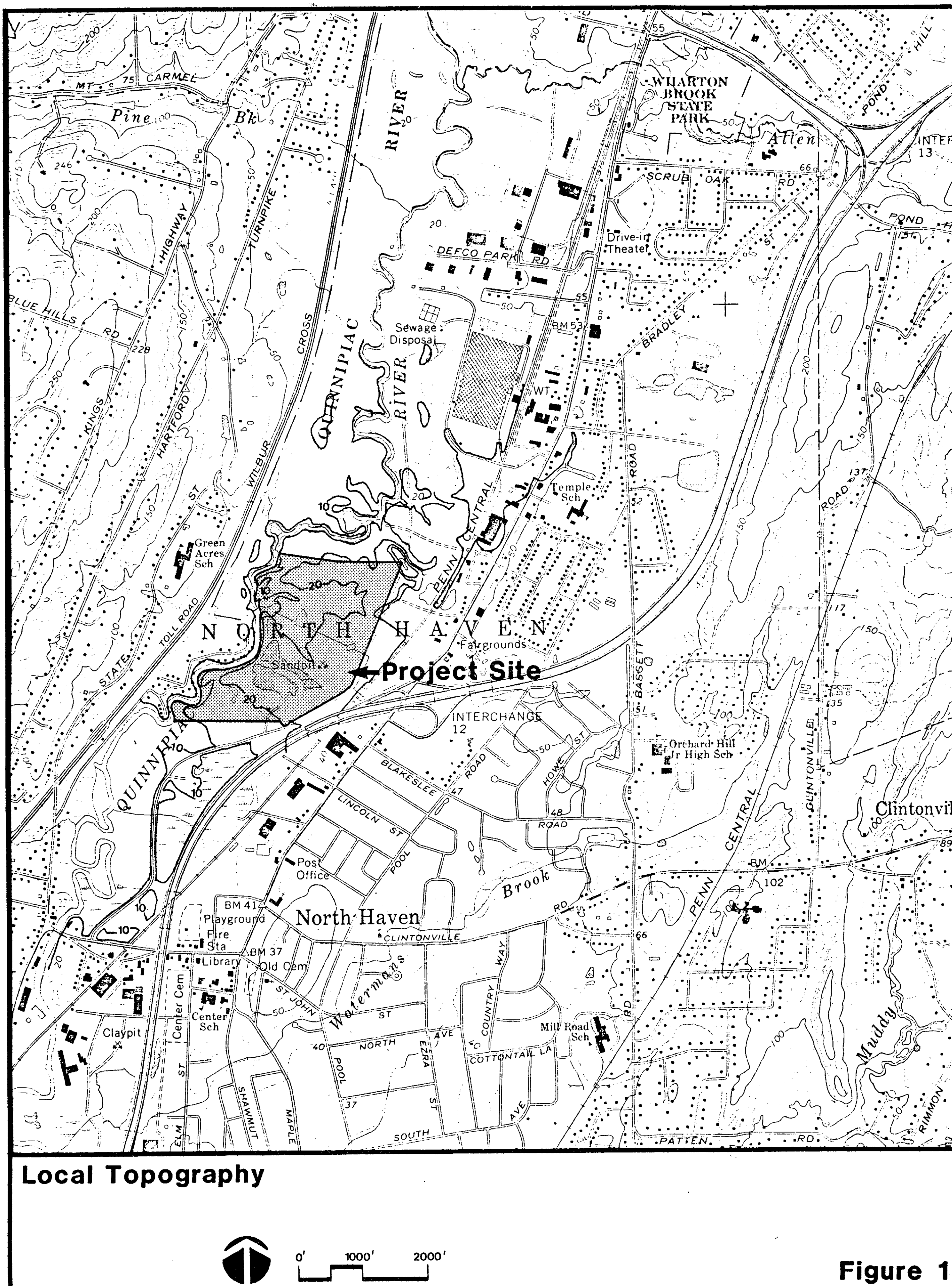
Comparison of historic data to present conditions also reveals a marked change. Recent topographic maps of the site generated during the project show three areas where modification of the ground surface was particularly extensive. These areas and the activities which caused the change are identified below.

1. Approximately 46 acres in the southern part of the site experienced major excavation, with certain depressions reaching -25 ft MSL, forming ponds of standing water. Such excavation was conducted by a sand and gravel operation which actively mined this area.

2. A storm drainage ditch, totaling approximately 2 acres, was constructed through the site, lowering the grade along its corridor from elevation +20 ft MSL to approximately +6 ft MSL. The ditch transects the site in an east-west direction and discharges directly to the Quinnipiac River. The ditch drains a watershed of approximately 800 acres which is composed of varying land uses, including numerous roadways and residential areas.

3. The area immediately north of this drainage ditch, totaling approximately 12 acres, was excavated from a prevailing elevation of +22 to +44 ft MSL to approximately +10 to +20 ft MSL. Materials removed from this area were used as borrow or fill for the construction of Interstate 91 in the early 1960's.

The cumulative effect of past earth removal activities at the project site has generally lowered the surface elevation of the site, in the process creating many small irregular landforms. Disturbance to the southern half of the site is particularly evident, where minor mounds and depressions predominate. Topographic irregularities are also present north of the drainage ditch, although their number and relief is limited. With the exception of the quarry ponds and bank cuts remaining from the sand and gravel mining operations, topographic relief at the project site is within a 10-12 ft range. The overall slope of the site is essentially flat. The topography in the vicinity of the site is shown in Figure 1; site topography is shown in Figure 2.

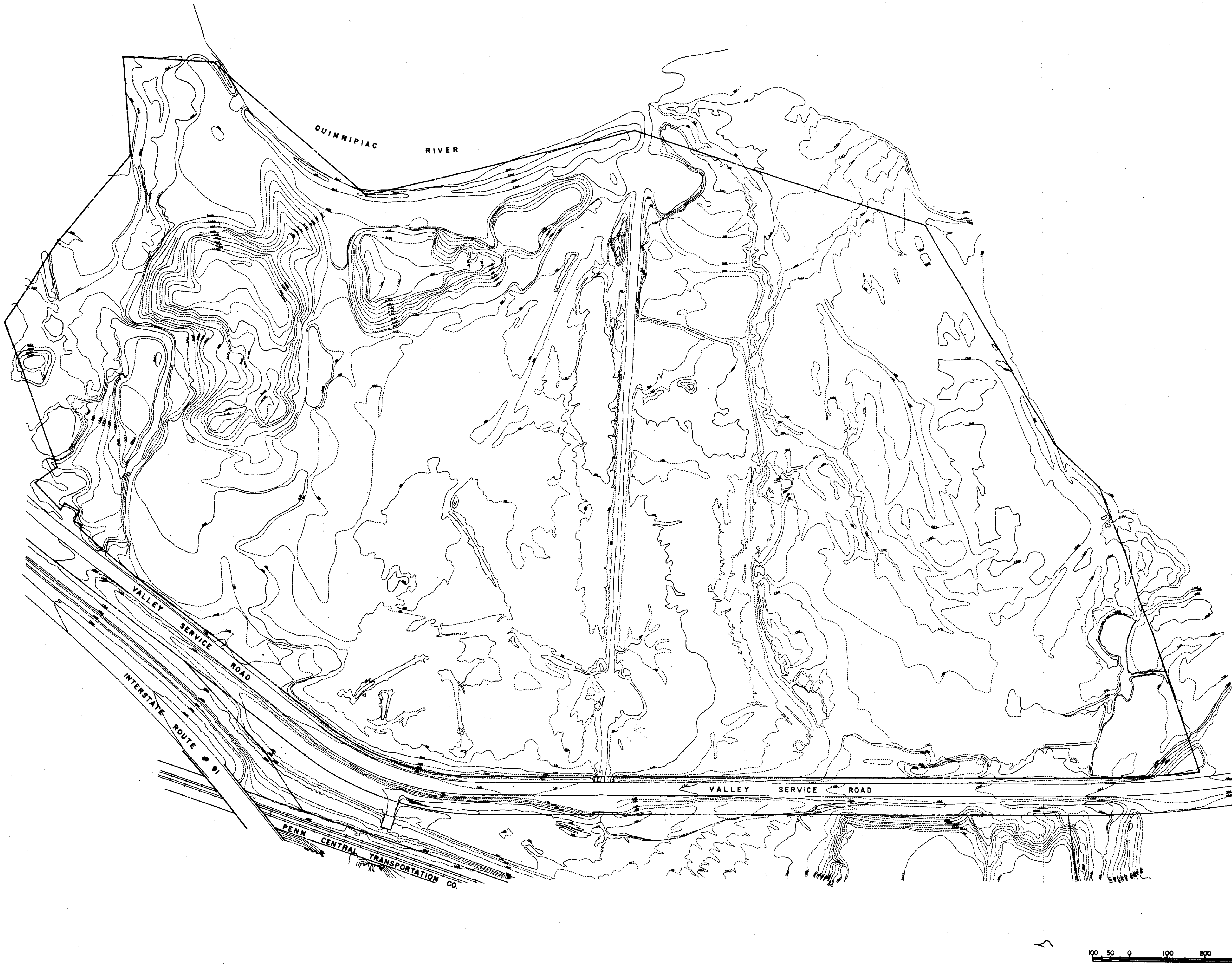


Local Topography

Figure 1

Figure 2

SITE TOPOGRAPHY



MALL PROPERTIES INC.
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NORTH HAVEN MALL
VALLEY SERVICE ROAD
NORTH HAVEN, CONNECTICUT

TITLE:
TOPOGRAPHY

DRAWN BY:	T.K.L
CHECKED BY:	J.E.A
JOB NO.:	2819

FIGURE -2

2.1.2 Bedrock

Bedrock underlying the project site consists of Triassic sedimentary rocks belonging to the Lower New Haven arkose (Krynine, 1937; Porter, 1960). This formation is a mottled gray or pink, coarse-grained, resistant arkose generally occurring in the region southward of Meriden. The Lower New Haven arkose was derived from siliceous igneous rocks composed of granites, granite-gneisses, and pegmatites.

According to the USGS (1974), bedrock on the project site varies from elevation 0 ft MSL in the extreme northwestern portion of the site to 150 ft below MSL near the site's eastern edge (Figure 3). Such variations in the depth to bedrock may be attributed to glacial stream erosion. During late glacial time, prior to the deposition of surficial materials, both the Farmington and Pequabuck Rivers, which presently flow into the Connecticut River, flowed south into the Quinnipiac River. The flows from these surface water features eroded the bedrock floor of the Quinnipiac Valley. Changes in stream velocities produced by this flow, coupled with variations in the shapes of glacial deposition basins, resulted in irregular sedimentary deposition along this valley floor. Because of these variations in bedrock depth, both the depth and type of surficial deposits also vary, resulting in a wide range of groundwater conditions throughout the Quinnipiac River Valley.

Subsurface explorations of the project site conducted by Cahn Engineers, Inc. (1972) did not encounter bedrock. Their investigations ranged from 100 ft deep in the vicinity of the mall to 40 ft deep at the railroad by Mall Drive. Bedrock was also not encountered during the subsurface investigations conducted by Woodward-Moorhouse (1974 and 1975) and Woodward-Clyde (1978 and 1979).

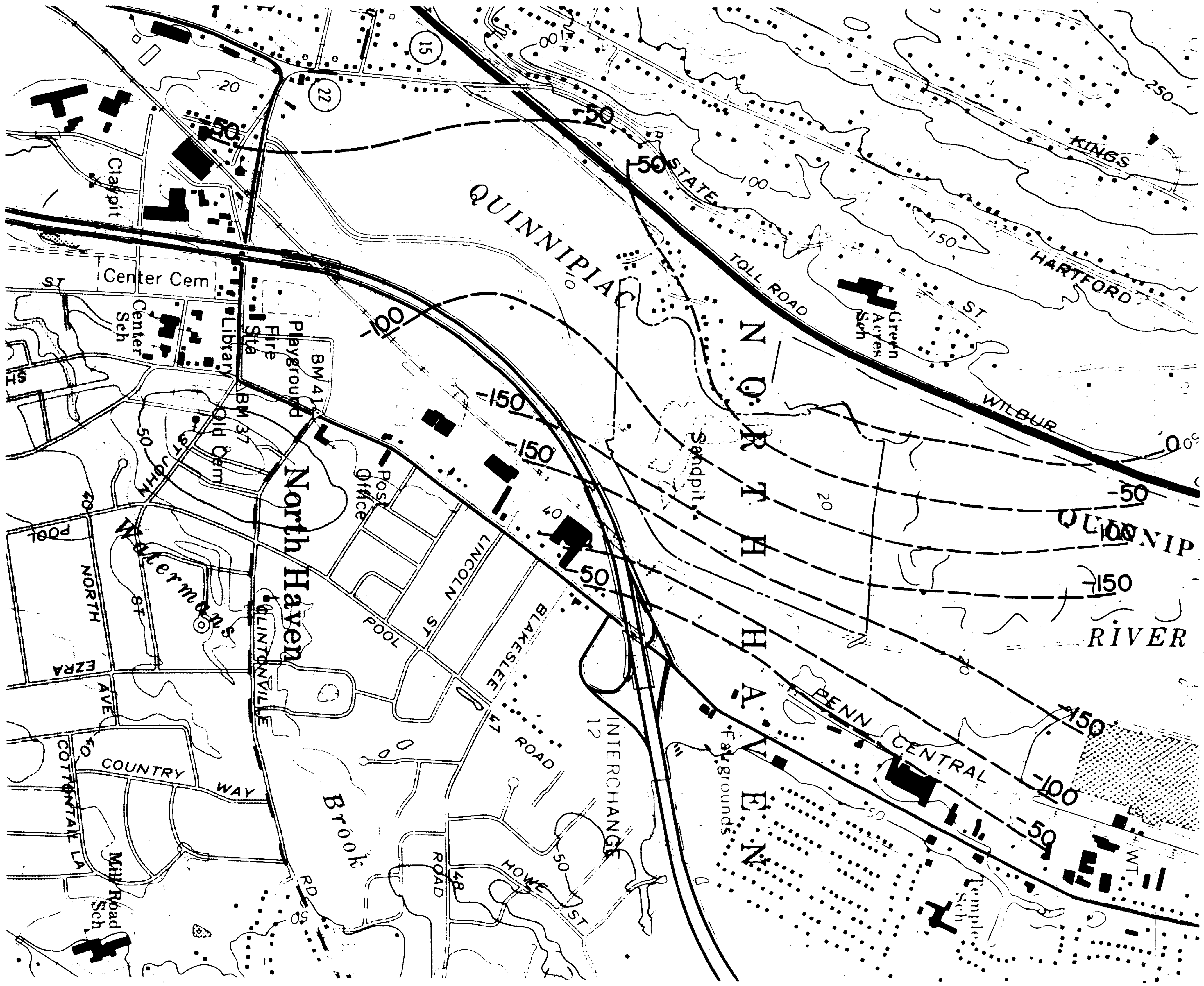
2.1.3 Surficial

Surficial geologic deposits occurring on the project site, shown in Figure 4, consist of glacial and postglacial material including ice-contact stratified drift, lake sediments, outwash, alluvium, and terrace alluvium (Cahn Engineers, Inc., 1972). Till, also a surficial deposit, was not encountered during the subsurface investigations conducted by Cahn Engineering, Inc. (1972). However, this material is expected beneath the site at a depth greater than 100 ft (Cahn Engineers, Inc., 1972). A description of the site's surficial deposits, as presented by Cahn Engineers, Inc. (1972), is cited below.

> During a period of continental glaciation, sediments were transported at the base of large southern moving ice masses. These sediments were plastered over the existing landscape in the form of an unsorted deposit of highly compacted sand, silt, gravel and clay termed till. Associated with the large masses of glacial ice were glacial streams, which flowed above, alongside or underneath the stagnant ice. These streams deposited stratified and size-sorted

Figure 3

BEDROCK CONTOURS



LEGEND:

-100 — ALTITUDE OF BEDROCK SURFACE ABOVE OR BELOW (-) MEAN SEA LEVEL

SOURCE : HAENI, 1974

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TITLE: BEDROCK CONTOURS

SCALE	
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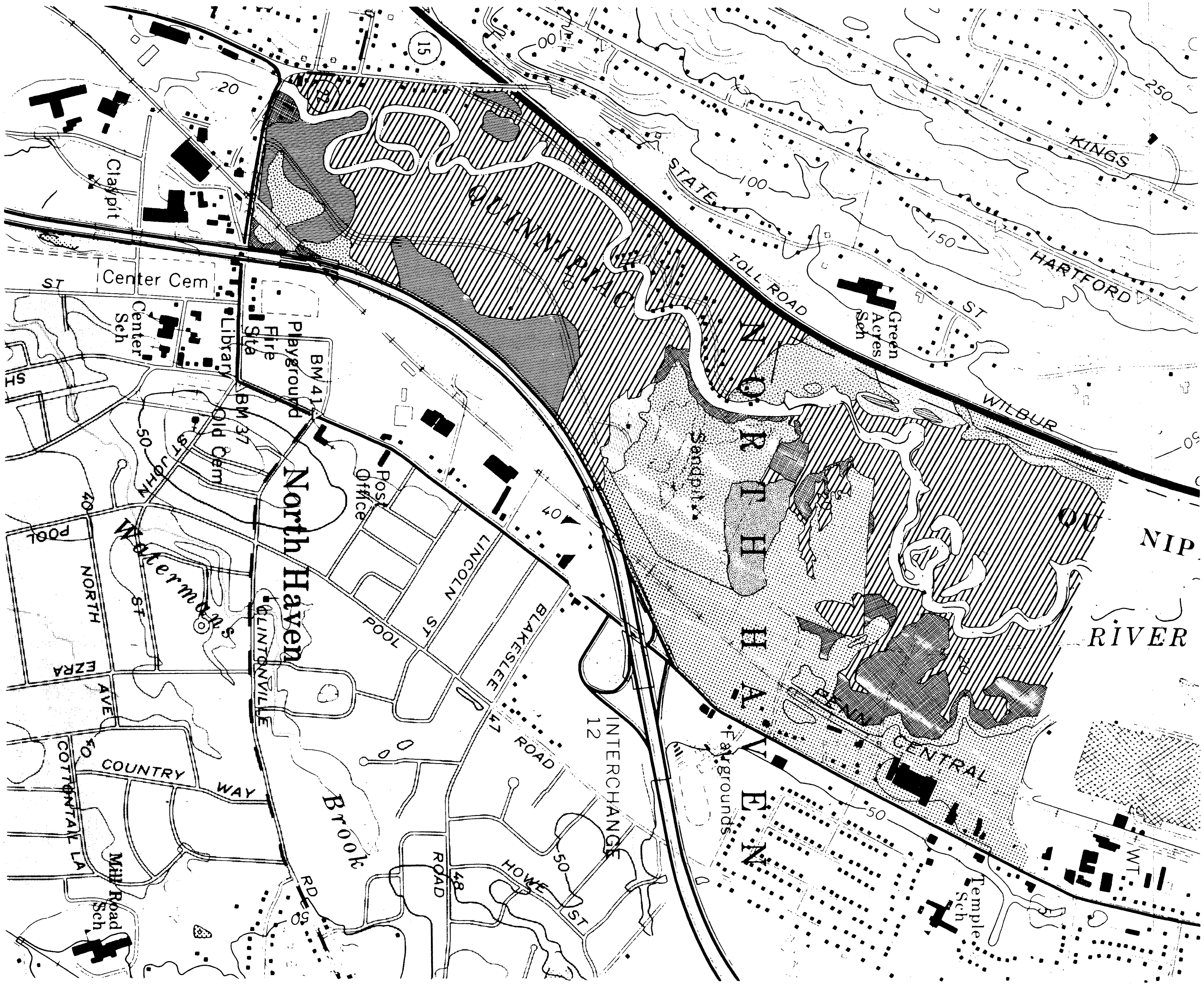
CHECKED BY	J E A
JOB NO	2819
DRAWING NO	FIGURE-3

Figure 4

SURFICIAL GEOLOGY



LEGEND:

- ICE CONTACT STRATIFIED DRIFT - SAND AND GRAVEL
- GLACIAL OUTWASH - SAND
- ALLUVIUM - SAND, GRAVEL, AND TRACE SILT
- TERRACE ALLUVIUM - SAND, GRAVEL, AND TRACE SILT
- FILL - SAND AND SILT
- GLACIAL LAKE DEPOSITS - SILT AND CLAY
- SWAMP DEPOSITS - ORGANIC
- TILL - SAND, GRAVEL, SILT, AND CLAY
- BEDROCK
- A—A CROSS SECTION

SOURCE : CAHN ENGINEERS, INC., 1972
PORTER, 1960

400 200 0 400 800 1200

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TITLE:
SURFICIAL GEOLOGY

SCALE:	
DATE:	
DRAWN BY:	L.L.L.
CHECKED BY:	J.E.A
JOB NO.:	2819
DRAWING NO.:	FIGURE-4

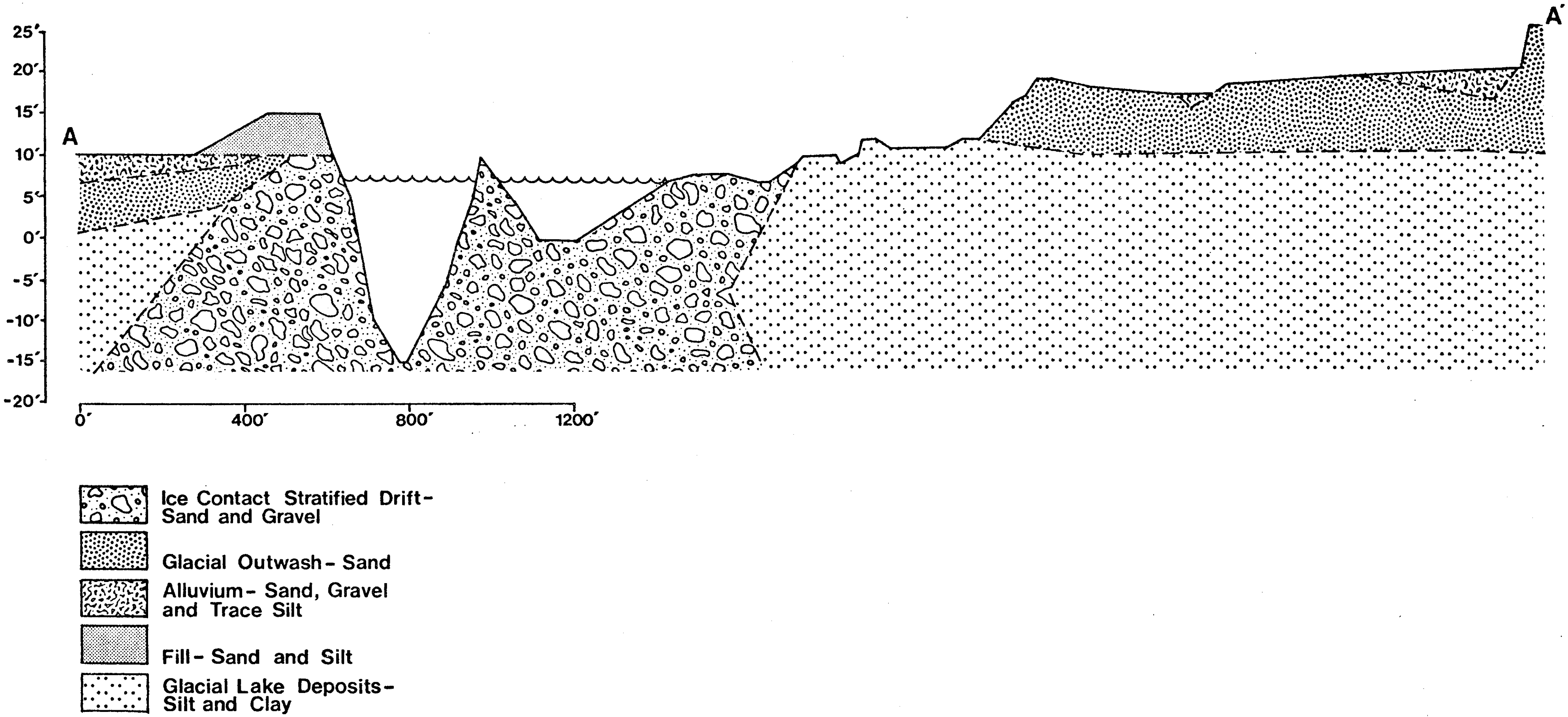
sand and gravel known as ice-contact stratified drift. When one of these glacial streams became dammed the stream would form a temporary glacial lake. In these glacial lakes, clay, silt, and some sand were deposited as lake-bed or lacustrine deposits. The glacial lake deposits are partly contemporaneous with and partly younger than the ice-contact deposits. During the retreat of the ice sheets, glacial outwash deposits consisting of sand and some gravel were laid down by the glacial meltwater streams.

These glacial outwash deposits often overlay the ice-contact deposits and lake deposits. Outwash deposits at one time probably covered the entire Quinnipiac Valley but the river has eroded them in its floodplain and redeposited them as alluvium. The alluvium is composed of reworked ice-contact deposits, outwash, and till. The alluvium is found in the floodplain and the river cut terraces of the Quinnipiac River. The alluvium overlies the ice-contact deposits, till and bedrock. (Terrace alluvium is alluvium deposited on river cut terraces and is composed of sand, gravel, and some terrace silt.) Associated with the recent alluvium are the swamp desosits. The swamp deposits consist of dark brown to black muck, fine-grained organic materials and clay, silt and sand-peat, leaf mold, and some interbedded sand and silt. These deposits are often found in low poorly drained areas along the flood plain of the Quinnipiac River.

As illustrated in Figure 4, onsite surficial deposits are primarily composed of ice-contact stratified drift, glacial outwash, and glacial lake sediments. Within the proposed development area south of the DOT drainage channel, surficial materials consist of coarse-grained deposits (sand and gravel: ice-contact stratified drift) which extend to a depth in excess of 100 ft. In contrast, the area north of the channel is composed of fine-grained materials (silt and clay: glacial lake sediments). Subsurface explorations conducted by Cahn Engineering, Inc. (1972) revealed that a great portion of this area is covered by a thin (predominantly less than 20 ft in depth) layer of granular materials of glacial outwash deposits and alluvium with glacial lake sediments (silt and clay) present beneath for a depth greater than 100 ft (Figure 5).

2.1.4 Soils

The primary soil association of the Quinnipiac River Valley is the Penwood-Manchester-Deerfield Unit (U.S. SCS, 1979). These soils formed mainly in material that weathered from Triassic sandstone. Penwood soils are typically deep, excessively drained, sandy soils that are nearly level to gently sloping. They occupy broad outwash plains on both sides of the Quinnipiac River. Manchester soils are deep, excessively drained, coarse textured soils that formed in sand and gravel. They are nearly level to sloping and occur on terrace breaks and the edges of broad outwash plains. Deerfield soils are deep, moderately well drained, sandy soils. They occur in nearly level and



Source: Cahn Engineers, Inc., 1972

Surficial Geology: Site Cross Section **Figure 5**

slightly depressional areas on broad outwash plains. Although Penwood, Manchester, and Deerfield soils comprise the majority of the River Valley, other soils are also present. As mapped by the Soil Conservation Service, and shown in Figure 6, the project area is composed of seven different soils. These include Deerfield loamy fine sand, Penwood loamy sand, Podunk fine sandy loam, Podunk Variant silt loam, Rumney Variant silt loam, Scarboro muck, and smoothed Udorthents. The last-named soil refers to well drained to excessively drained soil occurring in areas subject to earth disturbing activities. Such areas include cut or borrow areas, filled areas, and areas consisting of both cut and fill. The soil in this unit has a wide range of characteristics and because of its variable nature, onsite investigations are required for most proposed uses. The majority of the project site, i.e. the abandoned excavation area, is composed of this soil.

Based on numerous borings, the soils present at the project site consist of three basic groups, including granular, fine grained, and fill (Cahn Engineers, Inc., 1972). These three groups are derived from the following surficial geologic deposits:

1. Granular (sand and gravel) - ice-contact stratified drift, outwash deposits, terrace alluvium and alluvium.

2. Fine grained (silt and clay) - lake deposits.

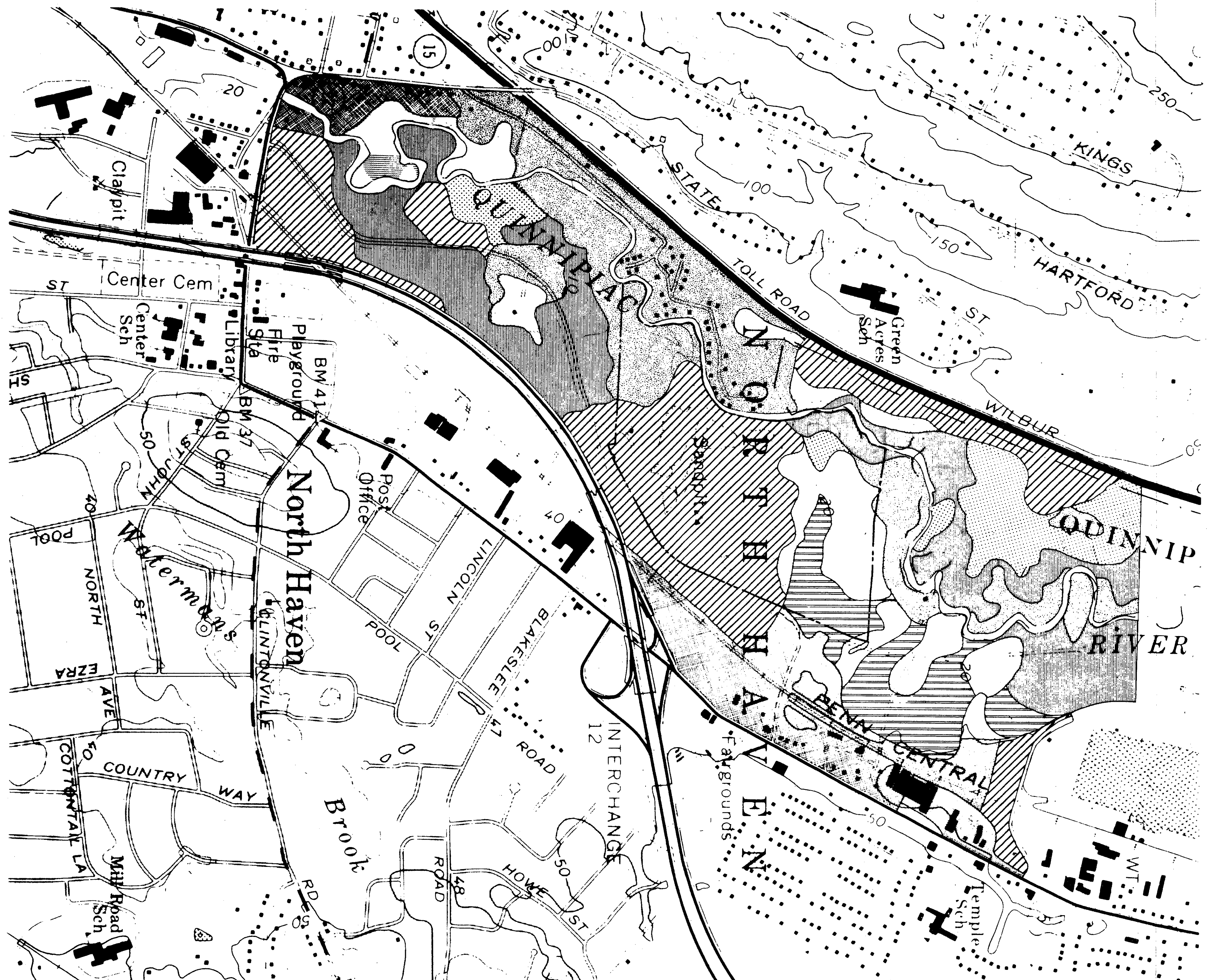
3. Fill (silt and sand with some rubble) - ice-contact deposits, outwash deposits, terrace alluvium, alluvium, and rubble.

Onsite boring also revealed topsoil to be limited in both extent and depth. Topsoil was recorded only in the northwestern and southwestern portions of the site and at no location did it exceed approximately one ft in depth. Subsequent subsurface investigations conducted by Woodward-Moorehouse and Associates, Inc. (1974 and 1975) and Woodward-Clyde and Associates, Inc. (1978 and 1979) were in general agreement with the site's soils as described by Cahn Engineering, Inc. Although variations in layer thickness among the borings were recorded, these should be expected owing to the complex geologic history of the area (Woodward-Moorehouse, 1974 and 1975; Woodward-Clyde, 1978 and 1979).

The erodibility of soils is typically represented by the factor K, which is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. The scale of K values theoretically ranges from zero to 1.0. Soils in New Haven County range from 0.10 to 0.64. Table 1 presents the K values for soils on the project site. Because of the variability of the central portion of the site where soils consist of smoothed Udorthents, a K factor has not been assigned to this area by the SCS. However, the relative sparseness of vegetation and topsoil, as well as the heterogeneity of this material, make it likely that the K value for this area may approach or exceed the highest K value given in Table 1. Based on a review of K values for other onsite soils, a K value of 0.43 is assumed for the smoothed Udorthents on the project site. Although this value may be exceeded in some areas where this soil occurs, it may also be less in other areas. As such, the value assumed represents a conservative estimate of this soil.

Figure 6

SOILS



400 200 0 400 800 1200

LEGEND:

- DEERFIELD LOAMY FINE SAND
- HINCKLEY AND MANCHESTER SOILS
- MANCHESTER GRAVELLY SANDY LOAM
- PENWOOD LOAMY SAND
- PODUNK FINE SANDY LOAM
- PODUNK VARIANT SILT LOAM
- RUMNEY FINE SANDY LOAM
- RUMNEY VARIANT SILT LOAM
- SCARBORO MUCK
- UDORTHENTS, SMOOTHED
- URBAN LAND

SOURCE U S SOIL CONSERVATION SERVICE, 1979

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TITLE

SOILS

SCALE	
DATE	
DRAWN BY	T.K.L.
CHECKED BY	J.E.A
JOB NO	2819
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As previously noted, the overall slope of the site is essentially flat. However, limited areas of relatively steep slopes do occur. These portions of the site include the berm along the Quinnipiac River and the area just north of the sand and gravel processing site. Each of these areas resulted from sand and gravel excavation. An additional area occurs along Valley Service Road, the result of the placement of fill for the roadway.

Table 1

SOIL ERODIBILITY FACTOR (K) FOR SOILS IN THE PROJECT SITE

Soil	Depth (Inches)	Erosion Factor (K)
Deerfield Loamy Fine Sand	0 - 8	0.17
	8 - 28	0.17
	28 - 60	0.17
Penwood Loamy Sand	0 - 8	0.17
	8 - 30	0.17
	30 - 60	0.17
Podunk Fine Sandy Loam	0 - 14	0.20
	14 - 34	0.43
	34 - 60	0.17
Podunk Variant Silt Loam	0 - 9	0.43
	9 - 36	0.43
	36 - 60	0.17
Rumney Variant Silt Loam	0 - 9	0.43
	9 - 31	0.43
	31 - 60	0.17
Scarboro Muck	0 - 12	--
	12 - 31	0.17
	31 - 60	0.17
Udorthents (Smoothed)	--	0.43 (approx.)

Source: U.S. Soil Conservation Service, 1979

2.1.5 Groundwater Resources

The quality and distribution of groundwater is largely dependant on the nature of surficial deposits. Coarse-grained surficial deposits (ice-contact stratified drift and glacial outwash), for example, typically yield greater volumes of water than such fine-grained surficial materials as glacial lake sediments. Additionally, the quantity of groundwater stored in these deposits varies with the depth of the stratified drift. Within the Quinnipiac River valley, stratified drift exceeds 200 ft in some locations (Porter, 1960).

Groundwater in the vicinity of the project site generally flows from east to west in the direction of the Quinnipiac River, though some southerly movement is also likely nearer the river. The most prominent water-bearing unit on the project site is the ice-contact stratified drift located in the central portion of the site, south of the DOT drainage channel. The stratified drift in this area exceeds 100 ft in depth (Cahn Engineers, Inc., 1972). Although outwash deposits usually associated with high groundwater yields (approximately 50-500 gpm; Mazzaferro, et al., 1979) occur north of the DOT drainage channel, the value of these areas for groundwater recharge is quite limited. This is attributable to the thinness of these deposits and the presence of relatively impervious glacial lake sediments (silt and clay) beneath the outwash. As previously noted, the outwash deposits in this area are mostly less than 20 ft in depth; while the lake sediments extend for a depth greater than 100 ft. Consequently, that portion of precipitation and surface runoff reaching this part of the site is impeded as it percolates through the surficial deposits. The silt and clay act as an effective barrier to water passing through the system.

The depth to groundwater on the project site is highly variable. Within the area to be occupied by the mall buildings, Woodward-Moorhouse and Associates, Inc. (1974 and 1975) recorded groundwater depths from 1.5 ft to 14.2 ft below surface elevations. This variability is consistent with earlier recorded depths to groundwater for the site which ranged from 1.3 ft to 16.0 ft below surface elevations (Cahn Engineers, Inc., 1972).

The permeability of site soils, as estimated from empirical correlations with the grain size of the soils, results in a coefficient of permeability varying from 10^{-2} to 10^{-3} cm/sec (Woodward-Clyde Consultants, 1978). These data indicate that the rate at which recharge occurs is relatively slow. This is primarily due to the underlying deposits, and the extent to which the site's soils are saturated during various times of the year.

Based on data available from published sources, the quality of groundwater onsite may be considered consistent with the overall groundwater quality of the region. LaSala (1968) described the regional groundwater quality as good, with the water quality not containing objectionable concentrations of any one constituent. Wells occurring within relatively close proximity to the project site include an industrial well associated with Pratt and Whitney north of the site, and a well associated with the sand and gravel operation in the southern portion of the site (Richard Gillen, Town Environmental Engineer, North Haven, CT, Personal Communication, 1981). Based on the fact that the South Central Connectict Regional Water Authority which supplies water to North Haven does not presently service Valley Service Road, it is likely that the residence located approximately 1,500 ft south of the project site is also serviced by a well. No wells in the immediate vicinity of the project site are known to be either impaired or contaminated. North of Scrub Oak Road, adjacent to Wharton Brook State Park, however, there is a private domestic well tapping unconsolidated surficial deposits that is contaminated; also south of Interstate 91 near Interchange 12, there is a non-residential (commercial, industrial, institutional, etc.) well tapping bedrock that is impaired (see Table 2) (Rolston et al., 1979). Given the local land use patterns, extensive areas of pavement, and high uses of roadway deicing compounds, one may anticipate

Table 2

LIMITS USED TO DETERMINE CONTAMINATION OR IMPAIRMENT OF GROUNDWATER

(Concentrations in milligrams per liter)

Constituent[a]	Contamination Lower Limit[b]	Impairment Lower Limit[c]
Arsenic (As)	0.05	--
Cadmium (Cd)	0.01	--
Chloride (Cl)	250.00	20.0
Chromium (Cr)	0.05	--
Copper (Cu)	1.00	--
Detergents (MBAS)	0.50	d
Hydrocarbons (organohalides)	--	d
Lead (Pb)	0.05	--
Nitrate and Nitrite (N)	10.0[e]	2.3[f]
Sodium (Na)	20.0	--

a Other chemical, physical, biological, and radioactivity characteristics were not considered.

b Water is considered to be contaminated if one or more constituents are in concentrations that exceed these limits; based on standards for public drinking water of the Connecticut Department of Health (Connecticut Assembly, 1975).

c Water quality is considered to be impaired if one or more constituents are in concentrations that exceed these limits. Lower limits have not been established for many constituents because of insufficient data.

d Not naturally present in water; presence indicates impairment.

e Equivalent to 44 milligrams per liter NO_3.

f Equivalent to 10 milligrams per liter NO_3.

Source: J. L. Rolston; I. G. Grossman; R. S. Potterton; and E. H. Handman, 1979.

that chloride and sodium concentrations in groundwater near the site would be in excess of the recommended concentrations in water for consumptive use. Iron and manganese may also be above drinking water standards. This may be attributable to the nature of the water bearing strata (i.e. sand derived from crystalline bedrock) and the local urban uses which characteristically contribute considerable amounts of iron. Nitrate nitrogen would be expected to be within the 10 mg/l standard for drinking water. Hydrogen-ion concentrations may be slightly acidic and possibly at or below the lower limit of 6.5 pH units. The water is expected to be soft to moderately hard. There is no reason at present to anticipate a total dissolved solids in excess of the limit of 500.0 mg/l.

2.2 Transportation Modification Areas

The following discussion addresses the existing geology and groundwater resources, soils, and topography associated with the primary transportation modification areas. These include the widening of Valley Service Road from Route 5/22 to the proposed mall site, the construction of a jughandle opposite Valley Service Road and south of Route 5/22, and the construction of Mall Drive between Washington Avenue and Valley Service Road. Mall Drive is proposed to meet Valley Service Road opposite the Mall's most northerly entrance and would join Washington Avenue approximately 1,200 ft north of the southbound entrance ramp for Interstate 91 at Interchange 12.

Topographic relief associated with these areas is primarily limited to the berms and embankments of Valley Service Road and Route 5/22. Elevations along Valley Service Road and Route 5/22 are generally approximately 20 ft above Mean Sea Level (MSL); whereas the base of the embankments is at approximately elevation 10 ft above MSL. Along the proposed Mall Drive, elevations range from approximately 20 ft above MSL adjacent to the project site to approximately 40 ft above MSL just west of the railroad tracks.

Depths to bedrock along the proposed transportation modification areas range from between 50 and 100 ft below MSL at the southern end of Valley Service Road to between 50 and 150 ft below MSL along Mall Drive. Subsurface investigations conducted by C.E. Maguire, Inc. (1979) revealed bedrock (red Triassic sandstone) to occur from 105 to 115 ft below surface elevations where Mall Drive intersects the railroad. Surface elevations in this area range from approximately 41 to 42 ft above MSL.

Surficial deposits along Mall Drive are limited to glacial outwash deposits (sand) (Porter, 1958; Cahn Engineers, Inc., 1972). Along Valley Service Road from the project site to Route 5/22, however, alluvium (sand, gravel, and some trace silt) and swamp deposits predominate. Alluvial sediments primarily occur west of Valley Service Road; while swamp deposits mostly occur in the wetland areas east of Valley Service Road.

Each of the soils represented on the project site are associated with the transportation modification areas. Mall Drive passes exclusively through Penwood loamy sand; while Valley Service Road overlays Rumney Variant silt loam, Podunk fine sandy loam, and Udorthents. Deerfield loamy sand and Podunk Variant silt loam occupy relatively small areas east and west of Valley Service Road, respectively. The proposed jughandle area consists solely of Rumney Variant silt loam.

With the exception of the embankment areas associated with Valley Service Road and Route 5/22, goundwater levels are expected to be near the surface in these areas. Along Mall Drive, however, C.E. Maguire, Inc. (1979) recorded groundwater levels ranging from 10 ft 9 in. to 12 ft 5 in. beneath surface elevations. As such, the groundwater table in this area is at approximately elevation 30 ft above MSL.

The potential for groundwater recharge along each of the transportation modification areas is limited. Similar to the northern portion of the project site, the Mall Drive area is underlain by thick, relatively impervious deposits of silt and clay. The depths below surface elevations at which these deposits are located range from approximately 20 to 31 ft (C.E. Maguire, Inc., 1979). East of Valley Service Road, organic swamp deposits, also a relatively impermeable material, curtail groundwater recharge. The alluvial deposits west of Valley Service Road and at the proposed jughandle site are somewhat more productive in terms of groundwater recharge. However, in relation to ice-contact stratified drift and glacial outwash deposits, the recharge potential of alluvium is limited.

3.0 ENVIRONMENTAL IMPACTS

3.1 Project Site

3.1.1 Topography

Existing topographic relief over the majority of the site will be altered by project implementation. The placement of approximately 700,000 yd^3 of fill material in onsite ponds and wet areas and an additional 400,000 yd^3 over the remainder of the area to be developed will raise surface elevations of the project area. As proposed, the lower level of the mall structure will be situated at elevation 16 ft above MSL, with the parking area to range from approximately elevation 12-33 ft above MSL. With the exception of the proposed detention pond, no topographic modifications are anticipated beyond the perimeter of the proposed mall and parking facilities.

3.1.2 Bedrock

As stated in Section 2.1.2, bedrock on the project site varies from approximately elevation 0 ft MSL in the extreme northwestern section of the site to 150 ft below MSL along the site's eastern boundary. The approximate depth to bedrock in the area to be developed ranges from approximately 50-150 ft below MSL. Because of the depths at which bedrock occurs, no blasting will be required in relation to the setting of foundations. Thus, no impact to bedrock will result from mall construction.

3.1.3 Surficial

Impacts to surficial deposits occurring on the project site are primarily limited to ice-contact stratified drift and glacial outwash, as most of the area to be developed will extend over these materials. However, some areas of alluvium, terrace alluvium, and glacial lake sediments in the vicinity of the Connecticut DOT drainage channel will also be affected. The placement of buildings and pavement over these deposits will serve to compact the sand, gravel, silt, and clay particles of which they are composed. The extent of compaction will likely be limited to the upper strata with settlements of approximately 0.3 to 3 in. being anticipated (Woodward-Moorhouse, 1974 and 1975; Woodward-Clyde, 1978 and 1979). Additional settlement of approximately 0.5 to 2 in. may be anticipated under the column footings due to the additional column loads. The implication of both soil compaction and the placement of an impervious surface over surficial deposits is primarily pertinent to the site's groundwater resources. A discussion of impacts related to these issues is presented in Section 3.1.5.

3.1.4 Soils

Impacts to onsite soil will primarily be derived from grading, earthwork activities, and the placement of fill in the development area. During construction, the upper soil strata will be removed and fill material graded to the appropriate contour. The strata to be removed will include topsoil and surface soil containing excessive amounts of roots, as well as soft soils unsuitable for the support of the proposed facility. Throughout the area to be developed, the fill material will be compacted, adding to the support capacity of the soils but somewhat reducing its permeability. Given the existing permeability coeffecient (10^{-2} to 10^{-3} cm/sec) for site soils, however, the impact associated with this reduction is expected to be minimal.

As indicated in Table 1, the erodibility factor (K) for onsite soils ranges from 0.17 to 0.43. According to Appendix D - Sediment and Erosion Control, the projected soil loss anticipated during construction with erosion control management is estimated to be 125 yd^3 per year over the 78 acres to be developed. It should be noted that during construction, eroded material will be directed through a series of existing ponds allowing for the settlement of sediment. The implementation of sediment and erosion control measures will substantially reduce existing erosion conditions. Additionally, areas composed of Podunk fine sandy loam and Rumney Variant silt loam, soil groups with moderate erosion potential, will not be affected by the proposed project. Onsite soils of the Deerfield, Penwood, and Scarboro group exhibit relatively low K factors. As a result, impacts associated with erosion are of primary concern where Podunk Variant silt loam and Udorthents occur. In these areas, particular care will be exercised in relation to erosion control. With the adherence to the Sediment and Erosion Control Plan and the planting of areas outside the development portion of the site, the extent of erosion subsequent to project completion will be less than presently exists (see Appendix D - Sediment and Erosion Control).

Although some of the fill for the project area will be taken from the project site, additional fill material will be required from offsite locations. Within the project area, the source of fill material includes the proposed detention pond, parking and building areas, and roadway areas. It has been estimated that approximately 655,000 yd^3 of fill material can be obtained from these areas (Raymond Keyes Engineers, P.C., 1980). As such, approximately 488,000 yd^3 of material will be required from offsite sources. This clean fill will primarily consist of coarse-grained materials, though some trace amounts of silt are also likely to be present. The fill material used during construction activities will not contain toxic substances or other unsuitable material, such as wood, which may result in the excessive settling of buildings and parking facilities. The offsite locations from which suitable fill will be extracted are not presently known. However, these locations, as well as the fill itself, will be subject to all pertinent regulations regarding earth removal and any required testing of the material will be conducted prior to approval for use.

3.1.5 Groundwater Resources

Impacts to regional and onsite groundwater resources resulting from mall construction and operation will not significantly affect ecological resources or human uses. This is primarily due to the nature of the site's subsurface material and the presence of the detention pond.

As previously noted, the compaction of underlying materials due to the combined weight of fill, mall structures, and parking areas will not be extensive. This is especially the case north of the Connecticut DOT drainage channel where fine-grained clay and silt predominate. Consequently, the water holding capacity of onsite surficial deposits and the quantity of groundwater onsite will remain effectively unchanged.

The placement of an impervious surface over approximately 78 acres will, however, reduce the recharge potential of the site. Rather than infiltrate through existing soils to the groundwater, precipitation and surface runoff reaching the developed area will be displaced either to the detention pond or to the Quinnipiac River. The loss of recharge potential in the northern portion of the site would have little effect due to the nature of the underlying deposits and this area's small practicable value as a source of water supply. These deposits of clay and silt act as an effective barrier to precipitation and surface runoff which have percolated through the more permeable outwash, alluvium, and terrace alluvium nearer the surface. Although some recharge occurs through the clay and silt, much of the recharge tends to follow the clay and silt surface and discharges into the Quinnipiac River with a relatively short residence period in the groundwater system. This is in marked contrast to recharge which, in fact, percolates into silt and clay deposits, and which typically has a lengthy period of residence in the groundwater system.

A reduction of the recharge potential in the southern portion of the site is also expected to be limited. This is primarily due to the small surface area of ice-contact stratified drift to be covered, the proximity of this area to the Quinnipiac River, and the relatively short residence time of recharge water in this area. Regardless of the presence of an impervious surface over this material, induced recharge from the Quinnipiac River will continue to occur. Recharge to the site derived from the lateral movement of groundwater from offsite areas to the east will also continue subsequent to project completion. Additional recharge will occur at each drain inlet. At these sites, the bottom of the structure will be left partially open with gravel material being placed underneath the bottom slab of the inlet to facilitate groundwater recharge.

The value of the site's groundwater resources as a municipal water supply is limited by the clay and silt deposits underlying both the northern and extreme southern portions of the site. Maximum anticipated yields (20-200 gpm; Mazzaferro, et al., 1979) from wells drilled into these deposits would not be sufficient for municipal purposes. Although wells drilled into ice-contact stratified drift in the central portion of the site may provide productive yields, the Town of North Haven presently has no plans to establish a municipal water source on the site or elsewhere in the Town (Salvatore Fazzino - Town of North Haven, Personal Communication, 1980). The Town of North Haven presently receives its water from the South Central Connecticut Regional Water Authority and there is no reason to believe this arrangement will not continue in the future. Furthermore, the available water supply of the service area in which the project site is located exceeds the current water usage. Thus, the additional demand of the Mall will not affect the ability of the water system to service all customers, even during dry weather conditions (See Appendix K - Utilities).

The quality of groundwater in the immediate vicinity of the project site, as well as the project area in general, is not expected to be affected by mall or detention pond construction and operation. As the majority of runoff (approximately 75 percent) from the mall and parking areas will be directed to the detention pond, the infiltration of potential contaminants to the groundwater will be effectively reduced. The fine-grained sediments covering the bottom of the detention pond will serve to adsorb a variety of the typical constituents of runoff, heavy metals for example, thus reducing the potential for surface and groundwater contamination (See Appendix E - Stormwater Management for a discussion of the detention pond specifications). The northwest portion of the development area where runoff will be directed to the Quinnipiac River is considerably smaller in terms of impervious surface area than the area to be drained by the detention pond. As such, the total amount of runoff resulting from the proposed project will be less in this area. Little opportunity exists for recharge in this area and the amount of recharge occurring will be of such limited quantities that no perceptible impact to groundwater quality is anticipated.

Given the negligible groundwater impacts anticipated, no wells are expected to be adversely impacted by project implementation. Regarding the Pratt and Whitney well, its location is upgradient from the project site. The private residential well located along Valley Service Road south of the project site is also expected to be unaffected because of its location in relation to groundwater flows and its distance from the project site. As the well associated with the sand and gravel operation will not be active subsequent to project completion, it will not be affected by construction or operational activities.

3.2 Transportation Modification Areas

Topographic impacts associated with the construction of most of the transportation modification areas will be minimal. Earth moving activities will occur along Mall Drive where proper grades must be established. At the site of the proposed bridge, elevations will be reduced from approximately 40 ft to 25 ft above MSL. Construction of a railroad bridge is proposed to carry the Penn Central railroad tracks over Mall Drive. The proposed bridge, to be located at the junction of Mall Drive and the existing railroad tracks, will consist of a single, simply-supported span with wingwalls running parallel to the railroad tracks. In addition, a structural slab will be constructed between the wingwalls to provide support for the railroad tracks and transition slabs will be provided both to the north and south of the wingwalls.

Subsurface investigations in the area of the proposed bridge indicate that the groundwater elevation is approximately 30 ft MSL. Based on the proposed profile of Mall Drive, dewatering of the excavation area during construction of the bridge and the permanent lowering of the water table in the immediate vicinity of the proposed structure will be required. Concrete will thus be poured in a dry environment to assure structural soundness. The required dewatering may be handled either by installation and pumping of well points or by pumping within the excavation area itself. The extent to which the local groundwater regime will be affected by the permanent lowering of the water table associated with bridge construction will be minimal and no adverse long-term impacts to the regional groundwater regime are expected.

A temporary impact from construction will result from the provision of a railroad detour during construction of the proposed bridge. The proposed detour will be a total of approximately 2,200 ft in length, extending from approximately 1,250 ft north of the proposed bridge to approximately 950 ft south of the bridge. As proposed, the detour will extend along the east side of the existing tracks at a maximum distance of approximately 100 ft from the present alignment. However, the area for which all these transportation modifications are proposed constitutes a very small portion of the total recharge area of the aquifer and thus, impacts to groundwater are expected to be minimal.

Because of the depth to bedrock (50-150 ft below MSL) along each of the transportation modification areas, no impacts to bedrock are anticipated. Surficial deposits to be affected along Mall Drive are composed of glacial outwash; whereas alluvium and swamp deposits will be affected along Valley Service Road and the proposed jughandle. As with the project site, impacts derived from the compaction of these materials due to the placement of fill and pavement are primarily related to groundwater.

Soil-related impacts from the proposed transportation modification are limited to the erosion potential of the soils to be disturbed. The soil associated with Mall Drive (Penwood loamy sand) has a relatively low erosion potential and erosion-related impacts in this area are expected to be minimal. However, the area to be widened along Valley Service road and at the proposed jughandle consists of Podunk fine sandy loam, Rumney Variant silt loam, and Udorthents, each of which exhibits a moderate erosion potential. Given the existing steep slopes of the embankment, the potential for the erosion of fill material placed along these areas is relatively high. Because the erosion of fill material may result in increases in turbidity and suspended solids in drainage channels and wetlands associated with Valley Service Road, adequate controls are required to curtail sediment erosion in the construction area. Such controls are addressed in Section 6.0, as well as in the Sediment and Erosion Control Plan.

Impacts to groundwater resources related to the transportation modification areas will be limited. When compared to the extent of the aquifer associated with the Quinnipiac River, the small amount of area to be covered with an impervious surface becomes insignificant. Mall Drive, for example, will cover approximately two acres. Groundwater recharge will continue to occur from the lateral movement of groundwater to these areas offsite. The roadway embankments will also provide recharge to the area's groundwater resources. Based on an examination of the proposed drainage plan for each transportation modification area, the opportunity for roadway-generated contaminants reaching the groundwater is minimal. Along Valley Service Road and the proposed jughandle south of the project site, roadway runoff will be directed via drainage channels to the Quinnipiac River. The surface runoff from Mall Drive, as well as that portion of the Valley Service Road constituting site frontage, will drain via drainage channels and pipes to the southern detention pond. The water will then be conveyed from the detention pond to the Quinnipiac River. Thus, no impact to regional or local groundwater quality is expected.

3.3 Cumulative Impacts

Cumulative impacts to regional and local geologic resources will primarily result from additional development within the aquifer associated with the Quinnipiac River. To assess the extent of these impacts, a variety of public agencies responsible for permit review and approval were contacted for information relative to recently approved and pending building permits in a portion of the Quinnipiac River Basin. These agencies included the Connecticut Department of Environmental Protection (DEP) regarding Wallingford and New Haven and the Towns of North Haven and Hamden. According to the information obtained from these agencies, a total of approximately 110 or more acres associated with 21 separate projects within the aquifer from Wallingford to New Haven are subject to potential development. Impacts derived from these developments will be similar to those discussed in relation to the proposed North Haven Mall, i.e. the compaction of surficial deposits and soils, soil removal and erosion, and a reduction in the recharge potential of the affected areas. The degree to which these impacts occur will be dependent on the precise nature of subsurface materials, the extent to which each site is developed, and the implementation of mitigative controls. Because of the unavailability of this information, a more definitive account of the cumulative impacts to geologic resources associated with potential development is not possible. When compared to the extent of the aquifer associated with the Quinnipiac River (approximately 23 square miles from New Haven to Meriden), the potential development areas, including the proposed North Haven Mall constitute approximately one percent of the total aquifer.

3.3.1 Secondary Development - Commercial/Office/Residential

Cumulative impacts may also occur from secondary development resulting from the construction and operation of the North Haven Mall. According to Appendix L - Economic and Land Use Impacts of the North Haven Mall, secondary commercial development is most likely to occur along Washington Avenue and the east side of Valley Service Road. Any additional office space is likely to occur only along the east side of Valley Service Road.

Commercial growth along Washington Avenue will probably be limited to the expansion of existing community shopping facilities and the more efficient utilization of existing space. Along the east side of Valley Service Road, approximately 60 acres, opposite and south of the project area between the North Haven Mall and Route 5/22, are potentially available for secondary commercial and office development. It should be noted that office space is projected to occur in either one office building or as second story office space above the retail establishments. As much of the area along Washington Avenue is already developed, cumulative impacts to geology and groundwater resources, soils, and topography will be primarily confined to the area along the east side of Valley Service Road.

Similar to those developments associated with recently approved or pending building permit applications, impacts derived from secondary development along the east side of Valley Service Road will likely include the alteration of existing topographic features; the compaction of surficial deposits and soils; soil removal and erosion; and a reduction in the recharge potential of affected areas. The degree to which these impacts may occur will be dependent on the precise nature of subsurface materials, the extent to which each site is developed, and the application of mitigative controls. Since the area of potential secondary development is smaller than the project site, it is expected that impacts to the aquifer associated with the Quinnipiac River will be less than those described for the proposed project.

Residential development generated as as result of the proposed project will be negligible. This is due to the likelihood of existing residential areas in the Town of North Haven supporting the estimated number of persons seeking residence in the Town as a result of the proposed project (See Appendix L - Economic and Land Use Impacts of the North Haven Mall). Thus, negligible, if any, cumulative impacts to geology and groundwater resources, soils and topography are expected to result from secondary residential development.

4.0 UNAVOIDABLE ADVERSE IMPACTS

Impacts of this type associated with project construction and operation primarily include the alteration of topographic features, the covering and subsequent compaction of surficial deposits and soils, the removal and limited erosion of soils, and a limited reduction of the recharge potential of the site and transportation modification areas.

Topographic alterations will result from the placement of fill and earthwork associated with grading activities. Portions of the site would be regraded to accommodate the proposed development.

Subsequent to the removal of soils unsuitable for support of the proposed facility, fill material will be placed onsite and compacted. The weight of the fill, when combined with the weight of the mall structure and parking area, would cause slight reductions in the existing permeability of underlying materials. Given the relatively slow rate at which water presently passes through the site's soils, the impact to surficial deposits and soils associated with this reduction in permeability is expected to be minimal.

Impacts associated with erosion are primarily short-term events occurring during construction. Where construction is proposed near the Quinnipiac River, existing drainage channels, wetlands, and those soils exhibiting moderate erodibility factors, control measures will be implemented to limit the amount of eroded material reaching these areas (See Appendix D - Sediment and Erosion Control). Because of the extent of exposed soils presently occurring on the site, the quantity of material subject to erosion will actually be reduced subsequent to project completion, as well as during the construction period. This is in large part due to the sediment and erosion controls to be implemented and the recommended landscaping efforts outside the development area where existing vegetation is sparse or nonexistent.

There will be a slight reduction in the permeability of affected soils and surficial materials and thus, a reduction in their water holding capacity. The extent of these impacts in relation to groundwater is expected to be minimal. As previously stated, the primary area of recharge on the project site consists of the ice-contact stratified drift in the central portion of the site. Although a portion of this area will be covered with an impervious surface, recharge will continue to occur from those areas of stratified drift unaffected by the project, as well as from the lateral movement of groundwater from offsite locations.

The same unavoidable adverse impacts outlined above for the project site are applicable to each of the transportation modification areas. However, because of the relatively small area associated with the proposed transportation modifications, impacts of this nature will be minimal.

5.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Commitments of this type primarily involve the placement of an impervious surface over that portion of the site to be developed. In this respect, project implementation will negate future opportunities for sand and gravel removal. Additional commitments include topographic modifications and a limited reduction in the recharge potential of the site and portions of the transportation modification areas.

6.0 METHODS TO MINIMIZE IMPACTS

The majority of measures which may be implemented to minimize the impacts previously discussed are presented in Appendix D - Sediment and Erosion Control. As such, these measures will not be described in this section. However, additional mitigative measures are available. These include the proposed detention pond, for example, which will serve to minimize the infiltration of runoff contaminants from the parking area into the groundwater. Also, the possibility of limiting the application of deicing compounds may be an available option to reduce opportunities for groundwater impacts.

All unvegetated areas outside the development area would be planted with indigenous species. This would serve to reduce the extent of erosion presently occurring in these areas.

Prior to construction, the limits of construction activity in all affected areas will be clearly defined, and activities related to site development and transportation modifications confined to this area (See Appendix D - Sediment and Erosion Control for construction details). Such efforts will limit the area of disturbances and the potential erosion of materials. Construction techniques for the proposed railroad bridge are designed to minimize potential compaction and consolidation of soils through the utilization of end-bearing piles. Non-displacement type piles are proposed to minimize disturbance to the subsoil. Moreover, all aspects of Appendix D - Sediment and Erosion Control will be adhered to and frequent monitoring efforts of the Plan's implementation will be made.

7.0 LIST OF CONTACTS

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APPENDIX B
Vegetation, Wildlife and Wetlands

NORTH HAVEN MALL

NORTH HAVEN, CONNECTICUT

1981

US Army Corps of Engineers
New England Division

Appendix B

Vegetation, Wildlife and Wetlands

The material contained in this appendix was prepared for Mall Properties, Inc., by Jason M. Cortell and Associates, Inc. It has been provided to the Corps of Engineers as information in support of application #13-79-561 for a permit under Section 404 of the Clean Water Act of 1977, and Section 10 of the River and Harbor Act of 1899.

VEGETATION, WILDLIFE and WETLANDS

APPENDIX B

NORTH HAVEN MALL
North Haven, Connecticut

Prepared For:
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July, 1981

WALTHAM, MASSACHUSETTS • GLADSTONE, NEW JERSEY

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1.0 INTRODUCTION

The proposed project involves the construction of an enclosed shopping mall consisting of approximately 1.12 million ft^2 of gross leasable area and ground level parking facilities for approximately 5,600 vehicles. The site of the proposed mall, which totals approximately 117 acres, is located in south central Connecticut, within the Quinnipiac River watershed, in the Town of North Haven. The proposed facility will occupy approximately 78 acres of the site, with a detention pond proposed for an additional area of approximately 16 acres.

From an historic standpoint, the east central portion of the site was considered part of a regional sand plain (Olmsted, 1937). This sand plain included a fifteen to sixteen mile long area along the east side of the Quinnipiac River from New Haven to Meriden (Britton, 1903). According to Britton, "Though perhaps once continuous, the area is now crossed by small streams which have cut their channels through the sand. In some instances alluvium has been formed along the beds of these streams supporting a somewhat different class of plants than is found on the plains. In this way the area is divided transversely into a number of small plains." The sand plain in the vicinity of the project area (North Haven Sand Plain) generally included a one mile wide area extending from Wharton Brook State Park southward on either side of Route 5 to approximately one-half mile north of Route 22 (Olmsted, 1937). The Sand Plain consists of an area of sandy deltaic deposits laid down by glacial Lake Quinnipiac. Whereas the predominant climatic climax community of southern Connecticut is probably a mixed mesophytic deciduous forest, Olmsted recorded no such climax forests for the North Haven Sand Plains. Instead, Olmsted described various xerophytic types of natural or semi-natural plant communities, "such as lichen-grassland, . . . scrub with various species of shrubs and low trees, and woodlands and low forests of pitch pine, black oak, grey birch, red cedar, etc."

Since Britton's and Olmsted's publications, the spread of industrialization and urbanization has left only remnants of native Sand Plain vegetation. One of the best remaining examples of this Sand Plain vegetation is located on the property of American Cyanamid north of the project site (Tom Siccama-Yale University, Personal Communication, 1980). Mining activities which have occurred on the project site have effectively eliminated the original Sand Plain communities which formerly existed in this area, and have done much to alter the vegetative and natural conditions of the site. For example, approximately 48 acres (62 percent) of the 78 acres to be developed have been altered as a result of mining activities. The alterations on portions of the site have also introduced wet conditions which presently support a vegetative regime substantially different from that which previously existed in these locations.

2.0 ENVIRONMENTAL SETTING

2.1 Vegetation

2.1.1. Project Site

The project site contains nine vegetative community types. These types include (1) upland forest, (2) successional shrub, (3) old field, (4) disturbed areas, (5) developed lands, (6) wooded swamp, (7) shrub swamp, (8) marsh, and (9) open water. As shown in Figure 1, upland forest, successional shrub, and old field communities are primarily located in the northern portion of the project site; disturbed and developed lands occur, for the most part, in the central and southern portions of the study area. Natural and man-made wetland communities are scattered throughout the project area*. As defined by the Corps of Engineers, wetlands include,

> "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 323.2(c)).

The classification and delineation of vegetation was based primarily on an analysis of 1975 aerial photographs (scale 1" = 1000') and numerous field investigations. The wetland boundaries were specifically marked in the field and subsequently surveyed. A discussion of each of the site's nine vegetative community types is presented below.

Upland Forest

Upland forest communities are limited to the northern and western portions of the project site. Typically, this community type exhibits a well-defined vertical stratification or layering. A stratum or layer may be defined as the horizontal part of a community in which plants are approximately the same height (Hanson, 1962). Canopy or overstory species in the upland forest occurring in the northern portion of the site are primarily composed of red oak, white oak, red maple, and black cherry; understory species include immature overstory species, arrowwood, mapleleaf viburnum, poison ivy, lowbush blueberry, sweet pepperbush, and several herbaceous species, among

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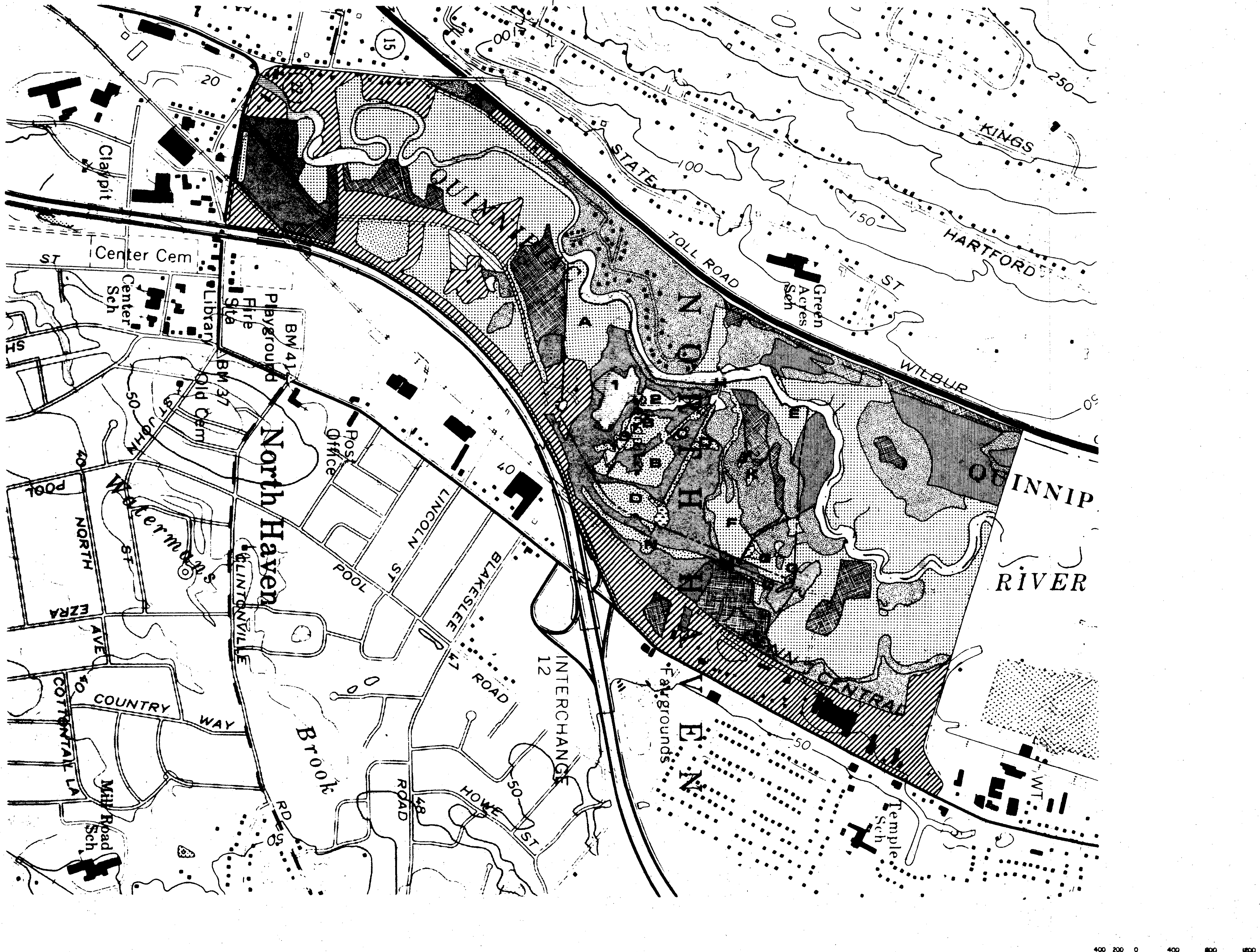
* The term "wetlands" is used herein to describe those areas of the site and nearby areas characterized as wetlands by the New England Division of the Corps of Engineers.

FIGURE 1

VEGETATION



LEGEND:

UPLAND FOREST
SUCCESSIONAL SHRUB
OLD FIELD
AGRICULTURE
DISTURBED
DEVELOPED
WOODED SWAMP
SHRUB SWAMP
MARSH
OPEN WATER
WETLAND AREA

SOURCE. JASON M. CORTELL AND ASSOCIATES INC., 1979 & 1980.

MALL PROPERTIES INC.
635 MADISON AVENUE
NEW YORK, NEW YORK 10022

NORTH HAVEN MALL
VALLEY SERVICE ROAD
NORTH HAVEN, CONNECTICUT

VEGETATION

T.K.L.
J.E.A.
2819
FIGURE 1

Table 1

APPROXIMATE NUMBER OF ACRES OF EACH VEGETATION COMMUNITY TYPE ON THE NORTH HAVEN MALL SITE*

Vegetation Community Type	Percentage of Site	Acres
Upland		
Upland Forest	17	20
Successional Shrub	2	2
Old Field	5	6
Disturbed	28	33
Developed	4	5
Subtotal	56	66
Wetland		
Wooded Swamp	20	24
Shrub Swamp	14	16
Marsh	1	1
Subtotal	35	41 **
Open Water		
Subtotal	9	10 ***
Total	100	117

* Acreages do not include vegetation community types associated with the transportation modification areas.

** This total includes approximately 24 acres of natural wetlands and 17 acres of man-made wetlands.

*** All open water areas on the project site are man-made.

others (See Attachment A for a list of the common and scientific names of plant species recorded for this and the following vegetative types). Along the west-central edge of the project site by the Quinnipiac River, the upland forest canopy is dominated by hemlock, with beech, black birch, red oak, and sugar maple present in lesser abundance. Understory species include, for example, mapleleaf viburnum, poison ivy, raspberry, false Solomon's seal, wild lily-of-the-valley, nightshade, and white wood aster. Based on field observations, the diversity and density of the site's upland forest communities is moderate, though some areas of dense understory vegetation are present. As shown in Table 1, upland forest communities comprise approximately 17 percent (20 acres) of the study area.

Successional Shrub

This upland community type occupies a relatively small portion of the project site. As previously noted, successional shrub communities are located in the northern portion of the property.

A variety of shrub and immature tree species dominate this community type. Such species include cottonwood, large-toothed and quaking aspen, choke cherry, black cherry, arrowwood, staghorn sumac, locust, and willow. However, several herbaceous plant species are also present. These species include goldenrod, bush clover, winter cress, tick-trefoil, hawkweed, and evening primrose, among others.

Successional shrub communities exhibit both a moderate diversity and density of plant species. However, because of their lack of trees, the spatial diversity of these areas in relation to upland forests, for example, is limited. Spatial diversity refers to the manner in which plants in a given area occupy the available volume, especially in terms of vertical height diversity. As shown in Table 1, successional shrub areas comprise approximately 2 percent (2 acres) of the project site.

Old Field

Old field communities represent the initial stages of secondary succession. Basically, secondary succession refers to floral community development proceeding in an area from which an existing vegetative community was removed, such as plowed field or cutover forest; while primary succession refers to succession which begins on an area which has not been previously occupied by a community, such as a newly exposed rock surface (Odum, 1959). Although both types of succession are usually unidirectional, eventually resulting in a climax community, secondary succession is usually more rapid. This is primarily because areas subject to secondary succession already exhibit many of the characteristics necessary to community development, such as soils, nutrients, and the ability to retain water. As a result, plowed fields, cutover forests, or areas which have been subjected to wind or fire are more receptive to the establishment and growth of plants than sterile areas where soils, for example, are non-existent.

In the project area, old field communities comprise approximately 5 percent (6 acres) of the site. These areas are located primarily in the northern portion of the site, although a small area of old field vegetation occurs along the site's southern boundary. Typically, this community type is dominated by herbaceous plant species. These include such species as goldenrod, bush clover, horsetail, winter cress, whorled loosestrife, wild violet, and broom beardgrass. A variety of woody plant species are also present. These species include, for example, red oak, gray birch, black cherry, pin cherry, smooth sumac, red cedar, and blackberry.

In contrast to upland forest and successional shrub areas, old field communities are fairly open, allowing for clear lines of sight from most points in the community. Additionally, old field communities do not exhibit a vertical stratification. Thus, the spatial diversity of these areas is quite low.

Disturbed Areas

Disturbed areas occupy approximately 28 percent (33 acres) of the project site. Until recently, this area had been used for the extraction of sand and gravel. Although some of this area has become revegetated since the suspension of mining activities, areas of exposed soils remain in evidence.

The site's disturbed areas exhibit a relatively equal complement of woody and herbaceous plant species. However, in terms of relative abundance, herbaceous species are most prevalent. Plant species common to this community type primarily include cottonwood, alder, willow, smooth sumac, red-osier dogwood, red cedar, Russian olive, ragweed, aster, mullein, wild carrot, yarrow, horsetail, white and red clover, dandelion, vetch, birdfoot trefoil, and broom beardgrass.

Like old field communities, the site's disturbed areas are fairly open and lack vertical stratification. Thus, the spatial diversity of these areas is also relatively low.

Developed

The area considered as developed is located in the southeastern portion of the project site and contains approximately 5 acres. This area is presently used in the processing of sand and gravel which is brought from offsite locations. Only scattered portions of the developed area are vegetated. Because of the sparseness of vegetation in the developed area and thus, its limited influence on wildlife, no formal listings of plant or wildlife species were prepared for this area.

Wooded Swamp

This community type is composed of naturally occurring wetlands located in the northern and southern portions of the site. As shown in Figure 1, wooded swamps include Wetlands A, E, F, H, J, K, and a portion of G. Unlike Wetlands J and K which are isolated, the remaining wooded swamp communities are associated with surface water features. Wetlands A, E, and H occur along the Quinnipiac River, while wetlands F and G are located next to intermittent streams. Collectively, wooded swamp communities comprise approximately 21 percent (24 acres) of the site. According to the U.S. Fish and Wildlife wetland classification system, the site's wooded swamp communities would be classified as palustrine forested wetlands (U.S. Fish and Wildlife, 1979). The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent. The class forested wetland is characterized by woody vegetation that is six meters tall or taller.

Based on the number of plant species recorded for each of the nine vegetative community types on the project site, wooded swamps are the most diverse vegetatively. Although overstory species are primarily composed of red maple, a wide variety of understory species are present. These include serviceberry, alder, red-osier dogwood, witch-hazel, sweet pepperbush, wild lily-of-the-valley, cinnamon fern, royal fern, sensitive fern, false hellebore, jack-in-the-pulpit, marsh marigold, and tall meadow-rue, among others. As with upland forests, wooded swamps exhibit a well-defined vertical stratification and a relatively high spatial diversity.

Shrub Swamp

Shrub swamp communities are limited to the central portion of the project site and occupy approximately 16 acres. As shown on Figure 1, this wetland community type includes Wetlands B, C, and portions of Wetlands D and G. The great majority of these wetlands occurs in the abandoned gravel pit and lies immediately adjacent to the site's disturbed area. These areas would be classified as palustrine scrub-shrub wetlands by the U.S. Fish and Wildlife Service. The class scrub-shrub wetlands includes areas dominated by woody vegetation less than 6 meters tall.

From a vegetative standpoint, the site's shrub swamps represent one of the least diverse community types. Dominant plant species include willow and cottonwood. Small patches of reed grass are also present. Additional plant species include alder, red maple, horsetail, jewelweed, purple loosestrife, cattail, nettle, rushes, and sedges.

With the exception of the shrub swamp community in Wetland G, the site's shrub swamp communities have formed as a result of mining activities and the excavation of material for the construction of Interstate 91 (See Appendix A - Geology and Groundwater Resources, Soils and Topography for a discussion of earth removal activities and topographic modifications). Based on numerous field investigations and an examination of past topographic maps and aerial photographs, it is apparent that quarrying activities have lowered the topography of this portion of the site. As a result, the difference in elevation between the present soil surface and the groundwater table has been reduced sufficiently to allow the growth of wetland plant species. It is unlikely, however, that the entire disturbed portion of the site will eventually become a wetland area. This phenomenon is due primarily to the variations in topography in this portion of the site.

In addition to the effects of quarrying activities, the drainage channel which transects the site in an east-west direction from Valley Service Road to the Quinnipiac River also plays a role in sustaining the shrub swamp communities. Prior to the construction of this channel by the Connecticut Department of Transportation (DOT) in the 1960's, water from the Quinnipiac River was primarily confined to the River channel, because of the presence of a natural berm located immediately adjacent to the River. Although the berm is, for the most part, presently intact, a breach in the berm was created in association with the drainage channel construction to allow surface waters to flow into the Quinnipiac River. This breach, however, also allows water from the River to enter the site. Thus, portions of the disturbed area and shrub swamp communities are flooded during periods of high water. It should also be noted that a second breach in the berm, the origin of which is unknown, occurs just west of Pond 1 and north of Wetland A. This breach acts in much the same manner as the breach associated with the drainage channel, i.e. during periods of high water, water from the Quinnipiac River enters the site through this breach.

Marsh

Two marsh communities totaling approximately 1 acre, are located on the project site. As shown on Figure 1, these communities occur in Wetlands D and G. The marsh community in Wetland D is man-made, while the area of marsh in Wetland G represents a naturally occurring wetland. These areas would be considered palustrine emergent wetlands by the U.S. Fish and Wildlife Service. The class emergent wetland is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years.

Similar to shrub swamps, the onsite marsh communities are also relatively limited in vegetative diversity. The marsh in Wetland D is nearly exclusively composed of reed grass; the marsh associated with Wetland G is dominated by sedge. Additional plant species occurring in the site's marsh areas include nettle, sticktight, joe-pye-weed, cattail, rush, purple loosestrife, jewelweed, sensitive fern, horsetail, highbush blueberry, sweet pepperbush, alder, and red maple, among others.

Whereas standing water is intermittent in the marsh associated with Wetland G, the marsh community in Wetland D has not been observed without open water being present. Concerning the latter, this may in part be due to the drainage channel which traverses this marsh area.

Open Water

Several surface water features are located on the site. These primarily include ponds, streams, and the previously noted drainage channel.

In relation to each of the other vegetative community types onsite, open water areas are the least diverse vegetatively. Plant species recorded for these areas include arrowhead, pickerelweed, water plantain, three-square bulrush, aquatic smartweed, spikerush, pondweed, and duckweed.

With the exception of the streams traversing Wetlands F and G, each of the other surface water features are manmade, having been constructed over the past several decades. Like the shrub swamp communities, the four ponds in the central portion of the site were formed as a result of mining activities. The remaining pond located west of Wetland G was constructed by an adjacent property owner; the east-west drainage channel was constructed by the Connecticut DOT.

2.1.2 Transportation Modification Areas

The following discussion addresses in general terms the existing vegetative communities associated with the primary transportation modification areas. These include the widening of Valley Service Road, the construction of a jughandle south of Route 5/22, and the construction of Mall Drive. For each community type noted, field investigations revealed a similar species composition to that recorded for the project site. A discussion of the approximate number of acres affected by the proposed transportation modifications is presented in Section 3.1.2.

The vegetation along Valley Service Road includes both upland and wetland community types. Upland communities include forest lands, agricultural areas, old field communities, disturbed, and developed areas. Wetland communities include wooded and shrub swamps. Upland forest and agricultural communities, as shown on Figure 1, are located south of the project site and east of Valley Service Road; old field communities occur south of the site, west of Valley Service Road. Developed areas are located on either side of the road, south of the project site. Disturbed lands primarily occur opposite the site east of Valley Service Road. Wooded and shrub swamp communities are located both opposite and south of the site on either side of Valley Service Road.

The site of the proposed jughandle south of Route 5/22 contains old field communities, disturbed areas, and wooded swamps. The old field areas are associated primarily with the Route 5/22 berm. Wooded swamp communities occur along the Quinnipiac River.

Vegetative community types associated with Mall Drive include successional shrub areas, old field communities, disturbed and developed lands, and shrub swamps. As shown on Figure 1, the majority of Mall Drive would traverse old field communities and existing developed areas.

2.2 <u>Wildlife</u>

2.2.1 Project Site

The project site provides suitable habitat for a typical variety of wildlife species. Some of these species may find all of their life-sustaining requirements (food, cover, water, and breeding sites) on the site; other species may use the area to fulfill only some of these needs.

Site investigations included approximately 20 man-days of effort. During this period, a total of sixty-five (65) species of wildlife were observed or in evidence. A list of the common and scientific names for these species is given in Attachment B. This list contains seven species of mammals, fifty species of birds, three species of reptiles, and five species of amphibians. Site investigations were conducted throughout the period from April, 1979 to May, 1980. As such, the species given in Attachment B represent the combined total of various seasonal observations. Although other species may be present on the project site, only those observed or in evidence on the site are listed in Attachment B.

The vegetative diversity of the project site in terms of upland and wetland community types allows for the presence of wildlife species typically associated with such areas. The site's open water areas provide suitable habitat for muskrats, great blue herons, herring gulls, northern water snakes, and eastern painted turtles, while providing only marginal habitat for waterfowl. This is primarily due to the lack of aquatic vegetation and the depth of onsite ponds. Wetland communities onsite also offer suitable habitat for several species. These species include, for example, raccoon, woodcock, veery, yellowthroat, red-wing blackbirds, northern water-thrush, alder flycatcher, northern water snakes, spring peepers, green frogs, pickerel frogs, and Fowler's toad.

Wildlife species typically associated with upland areas were also in evidence on the project site. These include such species as gray squirrel, woodchuck, cottontail rabbit, white-tailed deer, red-tailed and broad-winged hawks, black-capped chickadee, wood thrush, robin, starling, and eastern box turtle, among others. It should be noted that many of the wildlife species listed in Attachment B use more than one vegetative community type or group of types (upland and wetland) as sources of food, cover, water, or breeding locations and that the species listed do not necessarily exclusively use the community type or group of communities under which category they are cited.

In his study, The Rare Vertebrates of Connecticut, Craig (1979) included in his list the great blue heron, osprey, and common (Wilson's) snipe, each of which was recorded at the project site. However, only one sighting for each of these species was recorded and no nests were observed. Although Craig lists the great blue heron as rare and local, primarily due to its breeding status in the State, he also notes that their numbers may have increased in recent years as part of a general upward trend. He also regards the great blue heron as widespread and having "an extensive and relatively continuous range in which they are common or at least regularly occurring over a significant portion." The status of the common snipe is much the same as the great blue heron. According to Craig, the common snipe "has apparently always been an extremely rare breeder in Connecticut." Although not necessarily increasing in numbers, the numbers of this species have remained essentially unchanged in recent years. Craig regards the osprey as a rare, local, and State-threatened species. A State-threatened species, according to Craig, is a "taxa whose numbers have been undergoing a long-term, non-cyclic decline in Connecticut. They are becoming depleted to the point where they are approaching endangered status. Natural or man-caused events may be responsible for their decline."

An osprey was observed on the project site on April 23, 1980 taking a fish from one of the ponds in the central portion of the site. As ospreys occur primarily in coastal and estuarine areas, it is likely the individual observed was using the project area only as a source of food. No nests similar to those constructed by osprey were observed at any time, nor were any osprey observed subsequent to the initial sighting.

In addition to those species observed or in evidence on the project site, other species for which suitable habitat is present may use the area. These species include, but are not limited to, opossum, striped skunk, chipmunk, white-footed mouse, and a variety of other species of birds, reptiles, and amphibians.

2.2.2 Transportation Modification Areas

These areas also provide suitable habitat for a variety of wildlife. With few exceptions, the wildlife species given in Attachment B may also occur in the transportation modification areas. Species of wildlife observed or in evidence on the project site and not expected in the transportation modification areas primarily include great blue herons, mallards, black ducks, American widgeon, osprey, Wilson's snipe, spotted sandpipers, and herring gulls. This may be attributed to the lack of sufficient open water and shore areas commonly used by these species for resting, or as sources of food or breeding sites.

2.3 Threatened and Endangered Species

These species include vegetation and wildlife species listed as endangered or threatened at the Federal or State levels. According to the U.S. Fish and Wildlife Service (USF&W, 1980), seventeen species of wildlife are considered either endangered or threatened in Connecticut. These species are listed in Table 2. None of these species was recorded for the project site nor is it likely that these species will occur in this area in the future. This is primarily due to the lack of suitable habitat in the vicinity of the project area. No plant species in Connecticut are afforded official protection by USF&W.

At the State level, no official list of endangered or threatened species, other than the list developed by the USF&W, has been adopted. (Leslie J. Mehrhoff - Personal Communication, April, 1980). As a result, the only species of vegetation and wildlife afforded official protection in Connecticut are those species listed by USF&W.

According to a New England Botanical Club study (Mehrhoff, 1978), several plant species in Connecticut may be considered uncommon. However, none of the species listed in this study was recorded from the project site or transportation modification areas.

Table 2

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES IN CONNECTICUT

Common Name	Scientific Name	Status	Distribution
FISHES:			
Sturgeon, shortnose*	Acipenser brevirostrum	E	Connecticut River and Atlantic coastal waters
REPTILES:			
Turtle, green*	Chelonia mydas	T	Oceanic straggler in Southern New England
Turtle, hawksbill*	Eretmochelys imbricata	E	Oceanic straggler in Southern New England
Turtle, leatherback*	Dermochelys coriacea	E	Oceanic summer resident
Turtle, loggerhead*	Caretta caretta	E	Oceanic summer resident
Turtle, Atlantic ridley*	Lepidochelys kempii	E	Oceanic summer resident
BIRDS:			
Eagle, bald	Haliaeetus leucocephalus	E	Entire state
Falcon, American peregrine	Falco peregrinus anatum	E	Entire state - re-establishment to former breeding range in progress
Falcon, Arctic peregrine	Falco peregrinus tundrius	E	Entire state - migratory - no nesting
MAMMALS:			
Cougar, eastern	Felis concolor cougar	E	Entire state - may be extinct
Bat, Indiana**	Myotis sodalis	E	Entire state
Whale, blue*	Balaenoptera musculus	E	Oceanic
Whale, finback*	Balaenoptera physalus	E	Oceanic
Whale, humback*	Megaptera novaeangliae	E	Oceanic
Whale, right*	Eubalaena spp.(all species)	E	Oceanic
Whale, sei*	Balaenoptera borealis	E	Oceanic
Whale, sperm*	Physeter catodon	E	Oceanic
MOLLUSKS:			
None			
PLANTS:			
Smalled Whorled Pogonia	Isotria medeoloides	E (Proposed)	Harford, Litchfield, New Haven, Fairfield, New London, Windham Counties

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

** This species is not considered by the U.S. Fish & Wildlife Service to occur in Connecticut. However, it is recognized as a resident of the state by the Conn. Department of Environmental Protection.

Source: U.S. Fish and Wildlife, 1980; Connecticut DEP, 1979.

2.4 Wetlands Evaluation

2.4.1 Wetland Regulatory Policy

Federal

The Federal Water Pollution Control Act Amendments (FWPCA) of 1972 (Section 404) established a permit program, administered by the Secretary of the Army, acting through the Chief of Engineers, to regulate the discharge of dredged and fill material into the waters of the United States. The FWPCA (presently known as the Clean Water Act) also stated that applications for Section 404 permits were to be evaluated using guidelines developed by the Administrator of the Environmental Protection Agency (EPA), in conjunction with the Secretary of the Army. Interim final guidelines were published by the EPA in the Federal Register on September 5, 1975 and became effective upon publication. However, on September 18, 1979, the EPA released in the Federal Register proposed guidelines to revise and clarify the interim final guidelines.

Under the U.S. Army Corps of Engineers' (ACOE) revisions to the regulations governing the Section 404 permit program, general policies were established for the evaluation of all applications for Department of the Army permits (Federal Register, Vol. 42, No. 138; July 19, 1977). Among these policies was the determination of the effect on wetlands of a proposed action. Criteria to be considered in the evaluation of a proposed action and its effects on wetlands include:

"i. Wetlands which serve important natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing, and resting sites for aquatic or land species;

ii. Wetlands set aside for study of the aquatic environment or as sanctuaries or refuges;

iii. Wetlands the destruction or alteration of which would affect detrimentally natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics;

iv. Wetlands which are significant in shielding other areas from wave action, erosion, or storm damage. Such wetlands are often associated with barrier beaches, islands, reefs, and bars;

v. Wetlands which serve as valuable storage areas for storm and flood waters;

vi. Wetlands (which) are prime natural recharge areas. Prime recharge areas are locations where surface and ground water are directly interconnected; and

vii. Wetlands which through natural water filtration processes serve to purify water."

State and Local

At the State level, inland wetlands are regulated by the Department of Environmental Protection (DEP) under Sections 22a-36 to 45 of the General Statutes, as amended. In contrast to the definition of wetlands used by the ACOE which is primarily based on vegetation, the Inland Wetlands and Water Courses Regulations of the Connecticut DEP define wetlands as "land, including submerged land, . . . which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial, and flood plain by the National Cooperative Soils Survey, as may be amended from time to time, of the Soil Conservation Service of the United States Department of Agriculture." Wetlands are regulated by municipalities when they are empowered by municipal ordinance to implement and administer the Inland Wetlands and Water Courses Regulations. Otherwise, they are regulated by the Connecticut DEP. Since the Town of North Haven has adopted such an ordinance, the "Local Inland Wetlands Agency" has jurisdiction over the Town's inland wetlands and water courses.

On December 4, 1978, the North Haven Inland Wetlands Commission granted a conditional approval to Mall Properties, Inc. for the construction of the proposed North Haven Mall. Specific conditions to be met included the maintenance of a minimum 75 foot buffer along the Quinnipiac River and the nondisturbance of at least 11.6 acres of inland wetlands outside the flood (channel) encroachment line, among others. Each of these conditions will be met by the proposed development.

2.4.2 Evaluation of Site Wetlands

As previously cited, the ACOE lists seven functions important to the public interest which may be performed by wetlands. The following discussion addresses each of these functions in relation to the wetlands located on the project site. In each instance, the wetland function is listed. It should be noted that these wetland functions are characteristic of many other wetlands, though the extent to which these functions are performed varies between different wetlands.

i. "Wetlands which serve important natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing and restings sites for aquatic and land species."

All wetland communities, at least to some extent, perform a role in food chain production or provide habitat suitable for wildlife. Vegetation is a fundamental component of wetlands. In most typical food chains, plants serve as producers for consumer organisms, primarily animals. Also, since the availability of wildlife habitat is largely dependent on vegetation, any vegetated area will most certainly provide some of the life-sustaining requirements for various species of wildlife. Thus, it can be said that the site's wetlands do play a role in food chain production, as well as providing wildlife habitat.

Wetlands on the project site also provide nesting, spawning, rearing, and resting sites for aquatic and land species. For example, during field investigations conducted in May, 1980, a nesting flicker was observed in the wooded swamp in Wetland G, and it is likely that additional species breed onsite. A mating pair of northern water snakes was observed in the marsh community in Wetland G during this same period. Spawning alewives and carp were recorded from the ponds in the central portion of the site; a few fish spawning locations were noted in the shallower areas of the pond just west of Wetland G in the northeast portion of the site. The above-mentioned examples represent the only evidence of nesting, spawning, or rearing activity observed on the project site.

In relation to waterfowl, the value of the site's wetlands is limited. This is primarily due to the lack of aquatic vegetation and the depth of onsite ponds. Both submergent and emergent wetland vegetation play a key role in the diet of waterfowl. However, as their abundance is sparse, the site's wetlands may be considered of only marginal value to waterfowl. The lack of aquatic vegetation is due, in large part, to the absence of a suitable substrate in the ponds and the steepness of the ponds' edges.

ii. "Wetlands set aside for study of the aquatic environment or as sanctuaries or refuges."

The project site has not been set aside for any of the purposes noted above. In addition, no groups, either public or private, educational systems, or other interested parties are known to visit the site for the specific purpose of studying the aquatic environment. The Quinnipiac River State Park located immediately west of the project site, however, is available for such activities.

iii. "Wetlands the destruction or alteration of which would affect detrimentally natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics."

The construction of the proposed project will affect existing drainage characteristics, sedimentation patterns, and flushing characteristics. However, the project will not cause any environmentally significant adverse effects. Most of the drainage generated by the area to be developed (approximately 75%) will be directed to a detention pond located in the southern portion of the site, with a relatively small portion of the runoff from the developed area to be directed to the Quinnipiac River (See Appendix E - Stormwater Management). However, the effect of such drainage modifications on the water quality of the Quinnipiac River will be minimal (See Appendix C - Surface Water Resources and Water Quality). This is primarily due to the presence of the detention pond. The fine-grained sediments covering the bottom of the detention pond will serve to adsorb a variety of typical runoff constituents, heavy metals for example, thus reducing the potential for concentration of these elements in the ground and surface waters. Also, the suspended solids content of the water entering the Quinnipiac River will be reduced during detention. Additionally, it should be noted that the site's contribution of suspended solids during construction and subsequent to project completion will be less than presently occurs (See Appendix D - Sediment and Erosion Control). Although the proposed project will result in increased concentrations of various parameters entering the Quinnipiac River, these increases are not expected to significantly alter the concentrations in the River (See Appendix C - Surface Water Resources and Water Quality). The effect of mall construction and operation on sedimentation patterns and flushing characteristics are also expected to be minimal. This is due to the sediment and erosion controls proposed for the site and the site's relatively small storage area in terms of sediment loads (See Appendix D - Sediment and Erosion Control).

Although the area to be developed will no longer be subject to siltation during periods of high water, the displaced quantities of silt materials will be limited in relation to the normal extent of sedimentation presently occurring in the Quinnipiac River. The suspended sediment load in the River is approximately 1,485 tons during March and 636 tons during April. Assuming the maximum suspended solids levels found in the River are also present in water on the site, it has been determined that the site can store five-tenths of one percent of the monthly March sediment load and one percent of the monthly April load. The loss of such a small storage capacity for sedimentation will not impact any resources downstream in the River or New Haven Harbor (See Appendix C - Surface Water Resources and Water Quality).

Flushing refers to the manner by which water in a given area is exchanged, as well as the residence time of water in the area. Residence time refers to the amount of time water remains in a given area. Although each of these factors will be modified by the proposed project, the alteration of onsite wetlands will not affect these characteristics detrimentally.

iv. "Wetlands which are significant in shielding other areas from wave action, erosion, or storm damage. Such wetlands are often associated with barrier beaches, islands, reefs, and bars."

Due to the inland location and riverine nature of the project site, no coastal features are relevant.

v. "Wetlands which serve as valuable storage areas for storm and flood waters."

The value of the project site's wetlands for storage areas for storm and flood waters is quite limited. When compared to the total flood volume during the

100 year flood, for example, the volume of water stored by the site's wetlands becomes insignificant. According to Appendix F (Quinnipiac River Flood Study, North Haven, Connecticut), existing site storage during the 100 year flood is approximately 306.3 acre-feet; while the total flood volume for this same event is approximately 24,000 acre-feet. Based on these data, the site's storage capacity for the 100 year flood is approximately one percent of the total flood volume. Given that the site's wetlands represent approximately 35 percent of the project site and that not all of the site's wetlands are inundated during the 100 year flood, the volume of water stored by the site's wetlands during the 100 year flood constitutes less than one percent of the total flood volume. Regardless of the displaced storage volumes, it will, in part, be mitigated by the proposed detention pond (See Appendix E - Stormwater Management). It should also be noted that all of Wetlands A and E, and portions of Wetlands F and H, will remain subsequent to project completion and the storage capabilities of these areas will continue.

vi. "Wetlands which are prime natural recharge areas. Prime recharge areas are locations where surface and groundwater are directly interconnected."

Although some wetlands on the project site are directly connected to the groundwater regime, the amount of recharge which occurs in these areas is limited. These areas include the man-made wetlands located in the central portion of the site, i.e., Wetland C and the majority of Wetlands B and D. These wetlands provide a minimal recharge function. The rate at which water passes through these areas (coefficient of permeability) ranges from 10^{-2} to 10^{-3} cm/sec. These data indicate that the rate at which recharge occurs is relatively slow. Also, considering the relatively small wetland area in relation to the entire valley fill aquifer, the amount of recharge provided by these wetlands is limited. As each of the remaining wetland communities is underlain by thick clay deposits, they do not serve as prime recharge areas.

vii. "Wetlands which through natural water filtration processes serve to purify water."

Wetlands on the project site provide little function in water purification. Because of the relatively short residence time of water passing through the site, especially along the DOT drainage channel, the wetlands cannot effectively perform a significant role in reducing the levels of pollutants entering the site.

As previously noted, residence time refers to the amount of time water remains in a given area. Water entering the site from the twin 84 in. culverts just east of Valley Service Road passes through the site via the DOT drainage ditch. Given the channelized and linear nature of this ditch, and the limited amount of wetland vegetation in the area, the ability of this portion of the site's wetlands to significantly reduce contaminant levels is limited.

Water also enters the site from the Quinnipiac River during periods of high water. Wetland areas to be altered by the proposed project and presently affected during these periods primarily include Wetlands B, C, and D, with much of Wetland D consisting of the DOT drainage channel. As the size of these wetlands is relatively small and they are only periodically affected to varying extents during periods of high water, little opportunity exists for those wetlands to serve effectively to reduce the level of pollutants entering the site.

Although portions of the site's wetlands presently serve to reduce the suspended sediment concentrations of water entering the site, the quantity of sediment stored in these areas is quite limited. The suspended sediment load in the River, for example, is approximately 1,485 tons during March and 636 tons during April. Assuming the maximum suspended solids levels found in the River are also present in water on the site, it has been determined that the site can store five-tenths of one percent of the monthly March sediment load and one percent of the monthly April load. The loss of such a small storage capacity for sedimentation will not impact any resources downstream in the River or New Haven Harbor (See Appendix C - Surface Water Resources and Water Quality).

3.0 ENVIRONMENTAL IMPACTS

3.1 Vegetation

3.1.1 Project Site

Approximately 78 acres of the project site are proposed to be developed. This figure represents the proposed building and parking areas, but does not incorporate the area involved in detention pond construction. Such construction activity will primarily consist of the conversion of disturbed lands to an open water area.

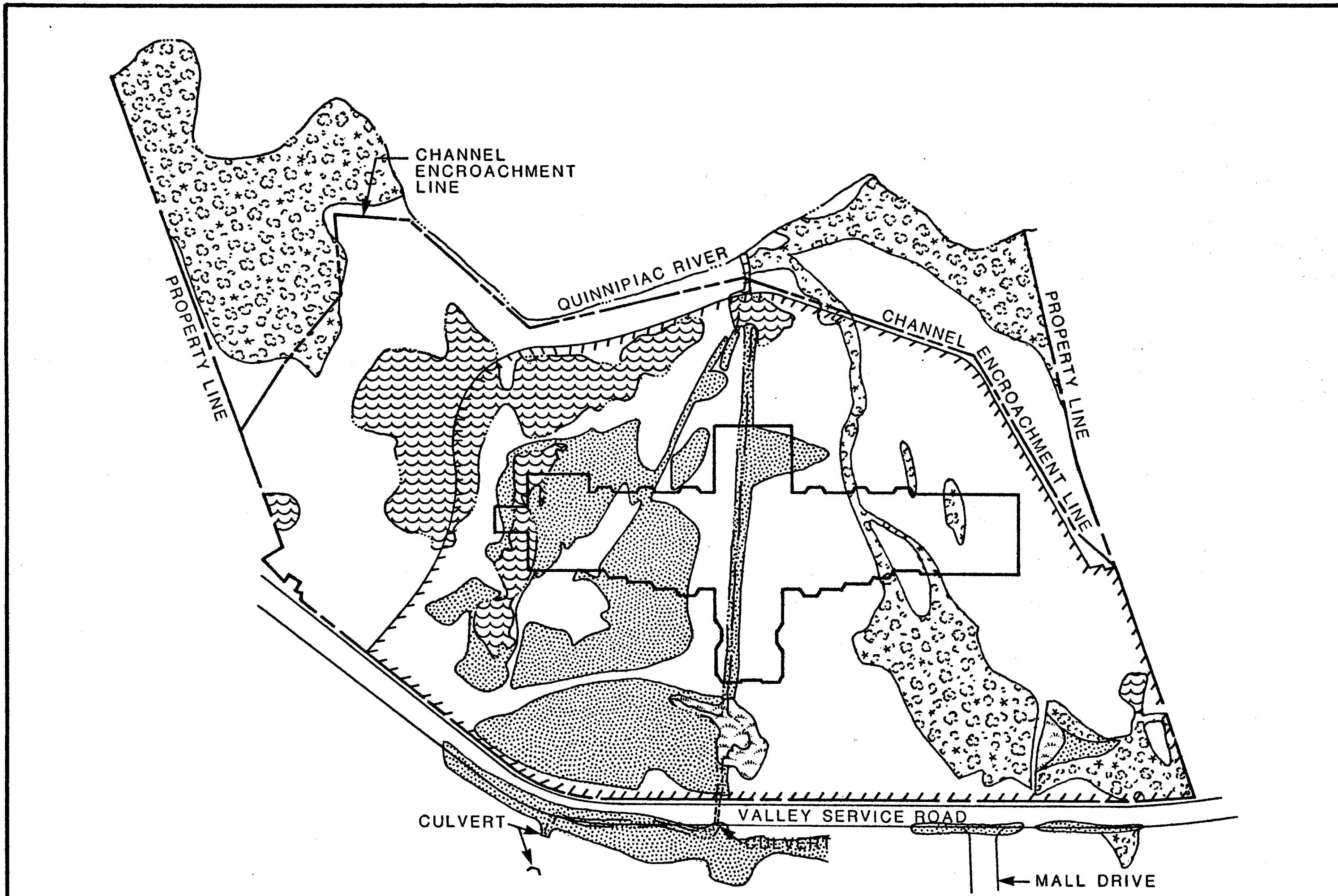
The losses of vegetation may be considered in terms of the acreage of each vegetative community type which would be taken should the project be constructed. These acreages are given in Table 3. Also given in Table 3 are the percentages of each of the site's vegetative communities which would be lost because of construction.

Examination of the total acreages taken by site development reveals the largest impacts, in terms of area, will be sustained by representatives of both upland and wetland communities, including upland forest, disturbed areas, and shrub swamp. As shown in Table 3, approximately 17 acres of upland forest, 26 acres of disturbed area, and 16 acres of shrub swamp will be removed for the proposed mall. Wooded and shrub swamp communities primarily affected include those located in the northern and central portion of the site, respectively (See Figure 2). A dissussion of wetland functions in relation to the proposed project is presented in Section 2.4.2.

The loss of approximately 78 acres to construction will reduce the vegetative diversity of the site, as well as the interspersion of vegetative communities. As indicated in Table 3, for example, all of the site's shrub swamp and marsh communities, which were primarily created by previous mining activities, will be removed. The vegetative diversity of the site in terms of the total number of communities will, thus, be reduced, as will the degree to which these communities are mixed and arranged. The extent of edge habitat will also be decreased. Edge areas, or ecotones, refer to transition areas between two or more different community types, such as between upland forests and old field areas. This transition area usually contains many of the same plant species found in each of the adjacent vegetative communities and typically exhibits a greater diversity and density of plant species.

3.1.2 Transportation Modification Areas

Vegetative impacts associated with the proposed access facilities primarily include the loss of upland vegetation. However, some wetland communities will be directly affected along Valley Service Road and south of Route 5/22. The approximate number of acres of each community type altered by the proposed transportation modifications is presented in Table 4.



NORTH HAVEN MALL
North Haven, Connecticut

0 250' 500'

JASON M. CORTELL and ASSOCIATES INC.

Wetlands-Site Plan Overlay

Wooded Swamp
Shrub Swamp
Marsh
Surface Waters
Limits of Development

Figure 2

Table 3

THE APPROXIMATE NUMBER OF ACRES OF EACH VEGETATION COMMUNITY TYPE ALTERED BY THE NORTH HAVEN MALL*

Vegetation Community Type	Percentage of Community Altered	Acres
Upland		
Upland Forest	85	17
Successional Shrub	50	1
Old Field	50	3
Disturbed	79	26
Developed	0	0
Subtotal		47
Wetland		
Wooded Swamp	33	8
Shrub Swamp	100	16
Marsh	100	1
Subtotal		25 **
Open Water		
Subtotal	60	6
Total		78

* Acreages do not include vegetation community types associated with the transportation modification areas.

** This total includes approximately 8 acres of natural wetlands (primarily wooded swamp) and approximately 17 acres of man-made wetlands.

The majority of upland vegetation altered by the widening of Valley Service Road is composed of herbaceous plant species typically located along roadsides. In terms of plant species composition, the roadside communities along Valley Service Road are similar to old field areas. However, because of the landscaping afforded these areas subsequent to the construction of the road, the diversity of plant species is limited. As a result, the upland vegetative diversity in the vicinity of Valley Service Road will be minimally affected by the proposed modifications. Wetland communities to be affected by the widening of Valley Service Road include areas of shrub swamp opposite the site east of the road and areas of wooded and shrub swamp south of the project site. The maximum distance any of the proposed roadway modifications will encroach upon wetlands is approximately 60 ft. In most of the transportation modification areas, however, wetland encroachment will range from only approximately 10-50 ft. As these areas are small in size,

Table 4

THE APPROXIMATE NUMBER OF ACRES OF EACH VEGETATIVE COMMUNITY TYPE ALTERED BY THE TRANSPORTATION MODIFICATION

	Transportation Modification			
Vegetation Community Type	Mall Drive	Valley Service Road	Jughandle	Total
Upland				
Upland Forest	--	0.1	--	0.1
Old Field	0.9	1.7	0.6	3.2
Disturbed	0.1	--	--	0.1
Developed	1.1	--	--	1.1
Subtotal	2.1	1.8	0.6	4.5
Wetland				
Wooded Swamp	--	0.1	0.1	0.2
Shrub Swamp	0.1	0.9	--	1.0
Subtotal	0.1	1.0	0.1	1.2
TOTAL	2.2	2.8	0.7	5.7

representing less than three acres, and their vegetative diversity is also relatively low, impacts associated with road widening activities will not be ecologically significant.

Plant communities affected by the construction of Mall Drive include disturbed, old field, developed, and shrub swamp areas. As illustrated in Figure 1 and Table 4, only a small portion of shrub swamp (approximately 0.1 acre) will be lost to construction. Similar to the widening of Valley Service Road, construction of the proposed jughandle just south of Route 5/22, will primarily affect only roadside vegetation. Wetlands affected by the construction of the proposed jughandle include a small area of wooded swamp (approximately 0.1 acre) adjacent to the Quinnipiac River.

Although not directly affected by the proposed transportation modifications, several wetland areas may be subject to indirect effects of construction activity. These wetlands include wooded and shrub swamp communities occurring adjacent to Valley Service Road and south of Route 5/22. During construction, eroded material may be deposited in these wetland areas. Should standing water be present at these times, both the turbidity and extent of suspended materials, for example, will increase. Additionally, the placement of excavated soils at or near the base of trees and shrubs may result in the loss of these plants. However, the overall vegetative impact in these areas resulting from construction and operation will be minimal, particularly due to the implementation of sediment and erosion control measures (See Appendix D - Sediment and Erosion Control).

3.2 Wildlife

Wildlife-related impacts resulting from the construction of the proposed project, both on the site and transportation modification areas primarily include the loss of upland and wetland wildlife habitat, the loss and displacement of wildlife species many of which are typically associated with urban and suburban areas, and a reduction of edge habitat and the extent of interspersion.

As previously noted and shown in Table 3, a total of appproximately 78 acres will be altered onsite due to construction. Of this total, approximately 47 acres are upland wildlife habitat; approximately 25 acres are wetland wildlife habitat; and approximately 6 acres are open water areas. During the construction process, it is likely that some wildlife mortality will occur. The majority of individuals affected include those belonging to less mobile groups of wildlife, such as small mammals, reptiles, and amphibians. Wildlife species capable of avoiding construction efforts, however, will be displaced. Displacement refers to the movement of wildlife species from those areas altered by construction to other suitable habitats elsewhere. Depending on the species, construction may result in either total, partial, or temporary displacement. Small mammals, for example, such as mice, voles, and moles, may be totally displaced because their home ranges are characteristically small and may be completely contained within the site. However, where construction results in the loss of an area used only for feeding and cover by larger mammals and birds, for instance, whose home ranges extend over a large area, the displacement will probably be partial. As a result, new sources of food and cover will have to be located by these species. As portions of the site begin to become revegetated subsequent to construction activities, a variety of wildlife species will eventually return to this area. Such portions of the site primarily include the periphery of the detention pond and the buffer area along the Quinnipiac River. Wildlife species which frequent such sites, such as small mammals and a variety of songbirds, will begin to reinhabit the area. Thus, displacement for some species may be considered only temporary.

However, assuming that the carrying capacity (the maximum number of a wildlife species which a certain area will support) of offsite habitats has been realized for all wildlife species to be displaced by the proposed project, a condition which represents a worst case situation, wildlife-related impacts will be more widespread. Rapid or large scale dispersal could, for example, result in changes in the structure (density, age distribution, sex ratio, abundance) of the balanced populations into which displaced species of wildlife emigrate (Odum, 1959). Mass dispersal and resultant "crowded" conditions could also cause increases in competition for food, breeding sites, and living space. This could, in turn, result in increased mortality rates for affected species, and particularly, for those individuals displaced. The evaluation of surrounding areas relative to their carrying capacities for those species to be displaced by project implementation would involve an intensive and extensive study over a relatively large area. However, assuming that the carrying capacities of offsite habitats have been realized and all displaced individuals do not successfully relocate, no long term or permanent effects on regional wildlife populations are expected.

It is likely that each of the three species included in Craig's list of rare vertebrates in Connecticut and recorded on the site will be displaced, at least to the extent the site is used by these species. These species include the great blue heron, osprey, and common (Wilson's) snipe. Based on the life history of these species and the fact that no nests were observed, it is assumed that their use of the site is only as a source of food, and that they are transient species in the project area. Moreover, these species do not typically limit their food sources to a single location. Furthermore, only one sighting for each of these species was recorded. Consequently, impacts to these species associated with site development are expected to be minimal.

In combination with the loss of wildlife habitat is the reduction of edge habitat and the extent of interspersion. Because of the diversity and abundance of plant species characteristic of edge areas, both the diversity and abundance of wildlife species in these areas is usually high. However, because of the disturbed nature of much of the site, this edge effect is relatively limited. As such, the loss of edge habitat is not considered to represent a significant wildlife-related impact. Associated with the loss of edge is the reduction of vegetative interspersion on the site. As a result of construction, the heterogeneity of the site's vegetative communities will be decreased and their value for wildlife consequently lessened.

To a certain extent, each of the wildlife impacts just noted for the project site also applies to the transportation modification areas. It is doubtful, however, that an individual of any species will be totally displaced by the proposed modifications. Moreover, the extent of these impacts will be markedly less than for the mall site. This is primarily attributable to the size of the affected areas and the nature of the proposed activities.

3.3 Endangered and Threatened Species

As none of the species listed by the U.S. Fish and Wildlife Service and thus, the State of Connecticut, as endangered or threatened appear on the project site, or transportation modification areas, they will not be impacted by the proposed project.

3.4 Cumulative Impacts

To assess the cumulative impact of the proposed project in relation to vegetation, wildlife, and wetlands, a variety of public agencies responsible for permit review and approval were contacted for information relative to recently approved and pending building permits for construction along the Quinnipiac River from Wallingford to New Haven, CT. These agencies included the CONN DEP regarding Wallingford and New Haven, and the Towns of North Haven and Hamden. The selection of these four towns in relation to the assessment of cumulative impacts was based on their proximity to the Quinnipiac River and the potential for such impacts to occur in these areas. Given the uncertainties associated with future developments, the entire realm of such actions cannot presently be projected. Thus, a more precise account of the impacts generated by these developments cannot be determined at this time.

According to the information obtained from these agencies, a total of approximately 110 acres or more associated with 21 separate projects along or within close proximity to the Quinnipiac River are presently subject to potential development. Of the total number of proposed developments, approximately eight will require either State or local inland wetland permits. Collectively, these eight projects comprise approximately 86 percent (95 acres) of the land subject to potential development. Although site plans and the precise number of wetland acres involved in each of these projects were not available, an examination of aerial photographs revealed that not all of the 95 acres consisted of wetland communities.

The implementation of these proposed developments will likely result in the loss of upland and wetland vegetation and wildlife habitat along the Quinnipiac River and a reduction in the vegetative and wildlife diversity of each development parcel. An additional potential impact is the disruption of wildlife movements along the River. Such disruptions, however, will likely be limited to larger species of mammals. The degree to which these impacts occur will be dependent upon the extent to which each site is developed and the application of mitigative measures. The existence of a buffer area along the River, for instance, will help mitigate the disruption of wildlife movements.

Based on the 1972 Inland Wetlands map for the Town of North Haven, approximately 2,100 acres of wetlands are located in the Town. Of this total, approximately 900 acres (43 percent) occur along the Quinnipiac River.

As previously noted, eight proposed projects in the Towns of New Haven, Hamden, North Haven, and Wallingford, totaling 95 acres along the River will require either State or local wetland permits.

Of this total, however, only approximately 20 acres occur in North Haven. Assuming a worst-case condition, i.e. all of this land is wetland, this acreage represents approximately 2 percent of the wetland acreage along the Quinnipiac River in the Town of North Haven; while the wetlands on the project site constitute approximately 5 percent of the wetlands adjacent to the River in the Town of North Haven.

Given the wetland acreage to be altered on the project site (25 acres) and assuming all 20 acres offsite will be altered as well, construction of the proposed project, as well as those developments recently approved or pending, would result in a loss of approximately 5 percent of the wetlands occurring along the Quinnipiac River in North Haven. In relation to the entire Town of North Haven, this construction would result in a 2 percent reduction in wetland acreage.

3.4.1 Secondary Development - Commercial/Office/Residential

Cumulative impacts may also occur from secondary development resulting from the construction and operation of the North Haven Mall. According to Appendix L - Economic and Land Use Impacts of the North Haven Mall, secondary commercial development is most likely to occur along Washington Avenue and the east side of Valley Service Road. Any additional office space, however, is likely to occur only along the east side of Valley Service Road.

Commercial growth along Washington Avenue will probably be limited to the expansion of existing community shopping facilities and the more efficient utilization of existing space. Along the east side of Valley Service Road, approximately 60 acres opposite and south of the project area between the North Haven Mall and Route 5/22 are potentially available for secondary commercial and office development. It should be noted, however, that office space is projected to occur in either one office building or as second-story office space above the retail establishments. As much of the area along Washington Avenue is already developed, cumulative impacts to vegetation, wetlands and wildlife will be primarily confined to the area along the east side of Valley Service Road. A discussion of the vegetative communities associated with the secondary development sites along Valley Service Road is presented in Section 2.1.2.

Similar to those developments associated with recently approved or pending building permit applications, impacts derived from secondary development along the east side of Valley Service Road will likely include the loss of upland and wetland vegetation and a reduction in the vegetation and wildlife diversity of the development area. The loss of all 60 acres identified as potentially available for secondary development constitute a worst case situation. However, the degree to which these impacts occur will depend upon the location of the area to be developed and the application of mitigation measures.

Residential development generated as a result of the proposed project will be negligible. This is due to the likelihood of existing residential areas in the Town of North Haven supporting the estimated number of persons seeking residence in the Town as a result of the proposed project (See Appendix L - Economic and Land Use Impacts of the North Haven Mall). Thus, negligible, if any, cumulative impacts to vegetation, wetlands, and wildlife are expected to result from secondary residential development.

4.0 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts resulting from the construction of the proposed project primarily include the loss of vegetation and wildlife habitat. As shown in Table 3, approximately 78 acres of vegetated land will be removed for the mall. This total includes approximately 47 acres of upland, 25 acres of wetland vegetation, and approximately 6 acres of open water. Associated with this loss of vegetation is a reduction in the vegetative diversity of the site, as well as the interspersion of vegetative communities and extent of edge habitat. Such vegetation-related impacts as the alteration of drainage patterns, and the siltation and turbidity of affected wetlands would occur to some extent, but a variety of design and construction-related measures will minimize these impacts. Thus, impacts to vegetation derived from these sources are expected to be limited.

In addition to the loss of wildlife habitat, unavoidable impacts to wildlife due to construction include the loss and total, partial, or temporary displacement of species and a reduction in the number of individuals that use the site. As previously noted, wildlife species which find some or all of their life-sustaining requirements in vegetated areas proposed for development will be forced to seek suitable habitats elsewhere. No threatened or endangered species at either the Federal or State levels will be affected by the proposed project. Unavoidable adverse impacts associated with mall construction include the loss of infrequently utilized habitat and the resultant partial displacement of the great blue heron, osprey, and common (Wilson's) snipe. Additionally, the loss of edge habitat and a reduction in the extent of vegetative interspersion will lessen the site's value as wildlife habitat.

To a certain extent, each of the unavoidable adverse impacts noted for the project site also applies to the transportation modification areas. However, because of the relatively small size of the areas to be affected and the nature of the proposed activities, unavoidable adverse impacts in the transportation modification areas will be minimal.

5.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Commitments of this type associated with the proposed project primarily include the permanent loss of approximately 78 acres of upland and wetland vegetation and wildlife habitat and the resultant reduction in the carrying capacity of the site in terms of wildlife. Subsequent to the completion of the project, those vegetated areas altered by construction will cease to function as they presently do in relation to wildlife.

6.0 METHODS TO MINIMIZE IMPACTS

6.1 Project Site and Transportation Modification Areas

Methods to minimize project construction and operation impacts primarily relate to sediment and erosion control, natural revegetation and landscaping, and responsible construction practices.

Erosion controls are of primary importance during construction and will aid in protecting the quality of potentially affected areas. Where eroded sediments may affect wetland areas, such as in the northwestern portion of the site, hay bales would be placed in such a manner as to curtail the flow of sediments into these areas. In terms of drainage, care will be taken to maintain the flow of water into and from wetland communities (See Appendix D - Sediment and Erosion Control for a discussion of control measures).

In relation to both vegetation and wildlife, it should be noted that over 30 acres of the project site, including approximately 16 wetland acres (See Figure 2), will not be developed and will continue to serve as habitat for wildlife. Additionally, the disturbed and developed portions of the site which are not presently vegetated will be planted with native species. Such an effort will expedite the establishment of vegetation and supply habitat suitable for several wildlife species. It will also provide a buffer for adjacent areas. The landscaping of the project site will provide opportunities for wildlife as well, particularly those species adapted to urban environments, such as a variety of small mammals and songbirds. The revegetation and landscaping of the project site as soon as possible following construction will also minimize vegetation impacts. This is especially true in relation to sediment and erosion control. Prior to construction, however, the limits of construction activity in all affected areas would be clearly defined and activities related to site development and transportation modifications would be confined to this area. Potential impacts to anadromous fish species will be mitigated by the proposed outlet structure between the detention pond and the Quinnipiac River. This structure will allow these species to enter the detention pond and permit the continued use of the pond for spawning.

6.2 Wetland Creation

Opportunities for the creation of wetlands on the project site are rather limited. In the southern portion of the site outside the development area, existing wetlands and the proposed detention pond effectively preclude wetland creation. Although an area potentially suitable exists in the northwestern portion of the site, the biological merit of creating wetlands in this area is of a questionable nature. This portion of the site is presently composed of four vegetative community types, including wooded swamp, upland forest, successional shrub, and old field areas. The occurrence of these four community types subsequent to project completion will foster maintenance of the site's vegetative and wildlife diversity. In contrast, their removal and conversion to a single wetland type will not serve to increase the diversity of vegetation and wildlife onsite. In fact, such efforts may well reduce the vegetative and wildlife diversity of this portion of the site.

6.3 Wetland Acquisition

The feasibility of acquiring wetland communities is dependent upon a variety of factors. These factors include, for example, the availability of the wetland for purchase, the use(s) for which the wetland is being acquired, wetland location and access, and the nature of surrounding areas.

Extensive wetland communities occur along the Quinnipiac River north and south of the project site. However, none of these areas is readily available for purchase. Opposite the site west of the Quinnipiac River, wetlands are controlled by the Connecticut DEP as part of the Quinnipiac River State Park. Immediately north of the site, wetlands are controlled by the Town of North Haven or are in private or corporate ownership (Pratt and Whitney). Similar ownership conditions prevail for the wetlands south of the project site.

7.0 LIST OF CONTACTS

Connecticut Department of Environmental Protection (Conn. DEP) - Inland Wetlands Office, Hartford, CT

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Attachments

Attachment A

A LIST OF PLANT SPECIES RECORDED FROM THE NORTH HAVEN MALL SITE

Common Name	Scientific Name	Upland Forest	Successional Shrub	Old Field	Disturbed	Wooded Swamp	Shrub Swamp	Marsh	Open Water
Red Maple	*Acer rubrum*	x	x			x	x	x	
Sugar Maple	*Acer saccharum*	x				x			
Red Oak	*Quercus rubra*	x		x					
Pin Oak	*Quercus palustris*					x			
White Oak	*Quercus alba*	x				x			
Black Birch	*Betula lenta*	x	x						
Gray Birch	*Betula populifolia*	x		x					
Cottonwood	*Populus deltoides*		x		x		x	x	
Quaking Aspen	*Populus tremuloides*		x						
Large-Toothed Aspen	*Populus grandidentata*		x						
Beech	*Fagus grandifolia*	x				x			
American Elm	*Ulmus americana*	x							
Black Gum	*Nyssa sylvatica*					x		x	
Tulip Tree	*Liriodendron tulipifera*	x							
Ash	*Fraxinus sp.*				x	x	x		
Black Cherry	*Prunus serotina*	x	x	x	x	x			
Choke Cherry	*Prunus virginiana*	x	x						
Pin Cherry	*Prunus pensylvanica*		x	x					
Locust	*Gleditsia triacanthos*		x		x				
Hickory	*Carya sp.*	x							
Sycamore	*Platanus occidentalis*				x				
Hemlock	*Tsuga canadensis*	x							
White Pine	*Pinus strobus*	x							
Sassafras	*Sassafras albidum*	x							
Serviceberry	*Amelanchier sp.*					x			
Alder	*Alnus rugosa*		x		x	x	x	x	
Arrowwood	*Viburnum recognitum*	x	x			x			
Mapleleaf Viburnum	*Viburnum acerifolium*	x							
Staghorn Sumac	*Rhus typhina*		x		x				

Attachment A

A LIST OF PLANT SPECIES RECORDED FROM THE NORTH HAVEN MALL SITE
(Cont.)

Common Name	Scientific Name	Upland Forest	Successional Shrub	Old Field	Disturbed	Wooded Swamp	Shrub Swamp	Marsh	Open Water
Smooth Sumac	*Rhus glabra*			x	x				
Poison Ivy	*Rhus radicans*	x			x	x			
Red-Osier Dogwood	*Cornus stolonifera*		x	x	x	x			
Silky Dogwood	*Cornus amomum*					x			
Witch-Hazel	*Hamamelis virginiana*	x	x	x		x			
Sweet Pepperbush	*Clethra alnifolia*	x				x		x	
Highbush Blueberry	*Vaccinium sp.*	x				x		x	
Lowbush Blueberry	*Vaccinium sp.*	x	x						
Willow	*Salix sp.*		x		x		x	x	
Spicebush	*Lindera benzoin*					x			
Winterberry	*Ilex verticillata*					x			
Elderberry	*Sambucus canadensis*					x			
Ironwood	*Carpinus caroliniana*					x			
Swamp Azalea	*Rhododendron viscosum*					x		x	
Buttonbush	*Cephalanthus occidentalis*							x	
Red Cedar	*Juniperus virginiana*			x	x				
Russian Olive	*Elaeagnus angustifolia*				x				
Wild Rose	*Rosa sp.*			x					
Blackberry	*Rubus allegheniensis*		x	x		x			
Raspberry	*Rubus sp.*	x			x				
Wild Strawberry	*Fragaria virginiana*				x				
Dewberry	*Rubus flagellaris*		x			x			
Sweetfern	*Comptonia peregrina*		x	x					
Honeysuckle	*Lonicera japonica*		x			x			
Wild Grape	*Vitis sp.*		x		x	x			
Spiraea	*Spiraea tomentosa*		x	x					
Sheep Laurel	*Kalmia angustifolia*	x							
Virginia Creeper	*Parthenocissus quinquefolia*				x	x			

Attachment A

A LIST OF PLANT SPECIES RECORDED FROM THE NORTH HAVEN MALL SITE
(Cont.)

Common Name	Scientific Name	Upland Forest	Successional Shrub	Old Field	Disturbed	Wooded Swamp	Shrub Swamp	Marsh	Open Water
Cinquefoil	*Potentilla canadensis*		x	x	x				
Ragweed	*Ambrosia artemisiifolia*				x				
Goldenrod	*Solidago sp.*		x	x	x				
Bush Clover	*Lespedeza capitata*		x	x	x				
Aster	*Aster sp.*				x				
Mullein	*Verbascum thapsus*				x				
Wild Carrot	*Daucus carota*				x				
Yarrow	*Achillea millefolium*				x				
Horsetail	*Equisetum arvense*			x	x	x	x	x	
White Clover	*Trifolium hybridum*				x				
Red Clover	*Trifolium pratense*				x				
Dandelion	*Taraxacum officinale*				x				
Winter Cress	*Barbarea vulgaris*		x	x	x				
Spurge	*Euphorbia esula*				x				
Burdock	*Arctium minus*				x				
Common Vetch	*Vicia sp.*				x				
Rough Avens	*Geum virginianum*				x				
Plantain	*Plantago lanceolata*				x				
Thistle	*Cirsium sp.*				x				
Tick-trefoil	*Desmodium sp.*		x		x				
Birdfoot Trefoil	*Lotus corniculatus*				x				
Evening Primrose	*Oenothera biennis*		x		x				
Field Pennycress	*Thlaspi arvense*				x				
Whorled Loosestrife	*Lysimachia quadrifolia*			x					
Wild Violet	*Viola sp.*			x		x			
Wild Geranium	*Geranium maculatum*					x			
Starflower	*Trientalis borealis*					x			
Hawkweed	*Hieracium sp.*		x						

Attachment A

A LIST OF PLANT SPECIES RECORDED FROM THE NORTH HAVEN MALL SITE
(Cont.)

Common Name	Scientific Name	Upland Forest	Successional Shrub	Old Field	Disturbed	Wooded Swamp	Shrub Swamp	Marsh	Open Water
Wild Lily-of-the Valley	*Maianthemum canadense*	x				x			
Trout-Lily	*Erythronium americanum*	x				x			
Nightshade	*Solanum dulcamara*	x							
White Wood Aster	*Aster divaricatus*	x							
Redberry Wintergreen	*Gaultheria procumbens*	x							
Pink Lady's Slipper	*Cypripedium acaule*	x							
Ground-pine	*Lycopodium obscurum*	x				x			
Creeping Jenny	*Lycopodium complanatum*	x							
Cinnamon Fern	*Osmunda cinnamomea*	x				x			
Royal Fern	*Osmunda regalis*					x			
Sensitive Fern	*Onoclea sensibilis*					x		x	
False Solomon's Seal	*Smilacina racemosa*	x				x			
False Hellebore	*Veratrum viride*					x			
Jewelweed	*Impatiens capensis*					x	x	x	
Jack-in-the-pulpit	*Arisaema triphyllum*					x			
Tall Meadow-Rue	*Thalictrum polygamum*					x			
Wild Sarsaparilla	*Aralia nudicaulis*					x			
Purple Loosestrife	*Lythrum virgatum*						x		
Skunk Cabbage	*Symplocarpus foetidus*					x		x	
Wild Onion	*Allium stellatum*			x					
Reed Grass	*Phragmites communis*				x		x	x	
Blue-Eyed Grass	*Sisyrinchium atlanticum*			x					
Broom Beardgrass	*Andropogon sp.*			x	x				
Sedge	*Carex sp.*		x	x		x	x	x	
Rush	*Juncus sp.*						x	x	
Marsh Marigold	*Caltha palustris*					x			
Cattail	*Typha latifolia*						x	x	
Iris	*Iris sp.*					x			

Attachment A

A LIST OF PLANT SPECIES RECORDED FROM THE NORTH HAVEN MALL SITE (Cont.)

Common Name	Scientific Name	Upland Forest	Successional Shrub	Old Field	Disturbed	Wooded Swamp	Shrub Swamp	Marsh	Open Water
Arrowhead	*Sagittaria latifolia*								x
Pickerelweed	*Pontederia cordata*								x
Water Plantain	*Alisma triviale*								x
Joe-Pye-Weed	*Eupatorium dubium*					x		x	
Curled Dock	*Rumex crispus*							x	
Sticktight	*Bidens sp.*					x		x	
Deertongue	*Panicum sp.*				x				
Water-Willow	*Decodon virticillatus*					x	x		
Three-Square Bulrush	*Scirpus americanus*						x		x
Nettle	*Boehmeria cylindrica*					x	x	x	
Aquatic Smartweed	*Polygonum amphibum*						x		x
Spikerush	*Eleocharis sp.*						x		x
Cleavers	*Galium aparine*				x	x			
Arrow-leaved Tearthumb	*Polygonum sagittatum*					x			
Sphagnum	*Sphagnum sp.*					x		x	
Pondweed	*Potamogeton sp.*								x
Duckweed	*Lemna sp.*								x

Attachment B

A LIST OF WILDLIFE SPECIES OBSERVED OR IN EVIDENCE
ON THE NORTH HAVEN MALL SITE
(Cont.)

Common Name	Scientific Name
Common Grackle	*Quiscalus quiscula*
Cowbird	*Molothrus ater ater*
Cardinal	*Richmondena cardinalis*
Rose-Breasted Grosbeak	*Pheucticus ludovicianus*
Goldfinch	*Spinus tristis*
Song Sparrow	*Melospiza melodia*
Greater Yellowlegs	*Totanus melanoleucus*
Alder Flycatcher	*Empidonax traillii traillii*
Brown Thrasher	*Toxostoma rufum rufum*
Red-Eyed Vireo	*Vireo olivaceus*
Blue-Winged Warbler	*Vermivora pinus*
Northern Waterthrush	*Seiurus noveboracensis*
Baltimore Oriole	*Icterus galbula*
Scarlet Tanager	*Piranga olivacea*
Indigo Bunting	*Passerina cyanea*
Towhee	*Pipilo erythrophthalmus*
Field Sparrow	*Spizella pusilla pusilla*

Reptiles

Northern Water Snake	*Natrix sipedon*
Eastern Painted Turtle	*Chrysemys picta*
Eastern Box Turtle	*Terrapene carolina*

Amphibians

American Toad	*Bufo americanus*
Fowler's Toad	*Bufo woodhousei fowleri*
Spring Peeper	*Hyla crucifer*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*

Attachment B

A LIST OF WILDLIFE SPECIES OBSERVED OR IN EVIDENCE ON THE NORTH HAVEN MALL SITE

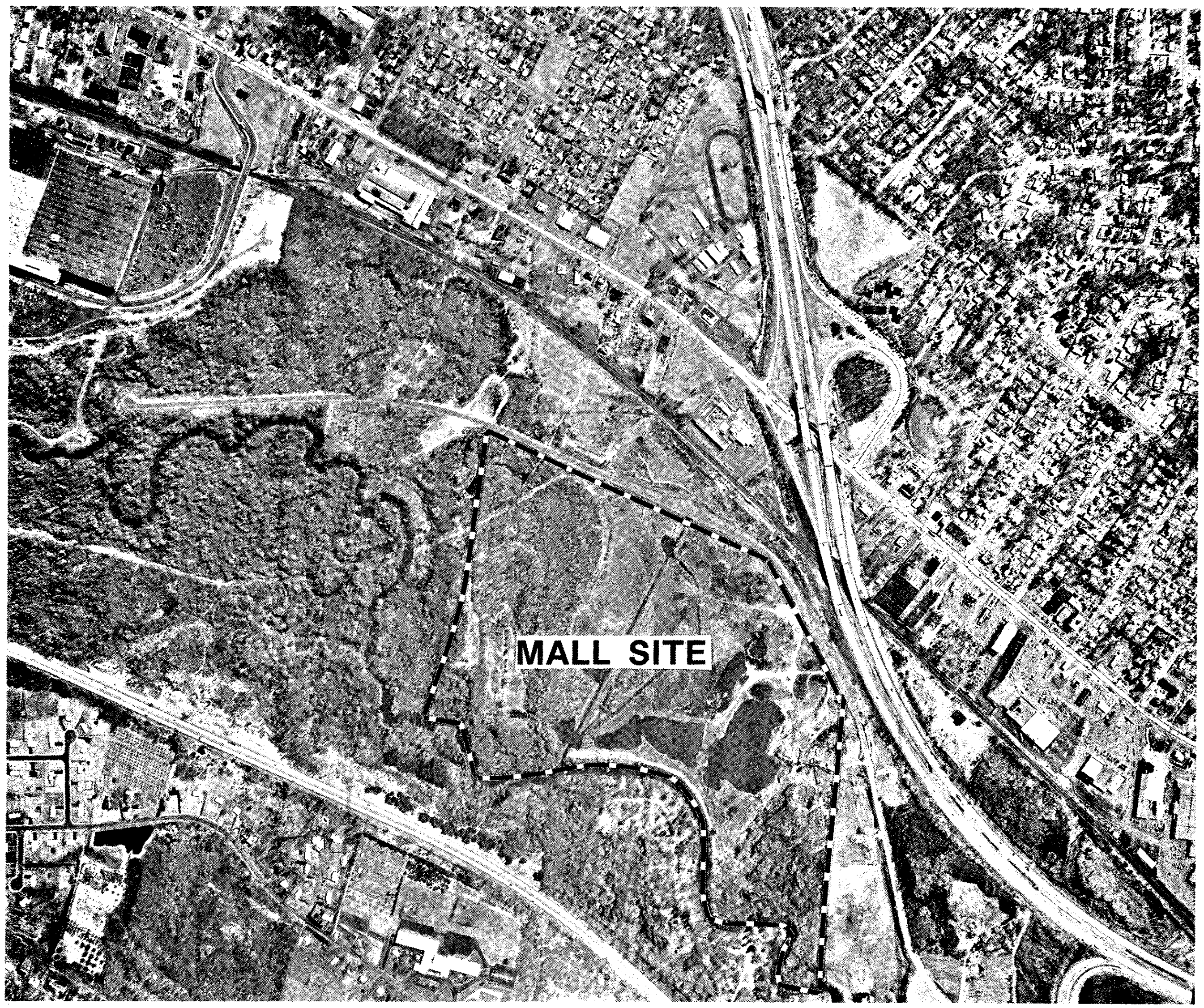
Common Name	Scientific Name
Mammals	
Gray Squirrel	*Sciurus carolinensis*
Muskrat	*Ondatra zibethica*
Raccoon	*Procyon lotor*
Woodchuck	*Marmota monax*
Cottontail Rabbit	*Sylvilagus floridanus*
Red Fox	*Vulpes fulva*
White-tailed Deer	*Odocoileus virginianus*
Birds	
Great Blue Heron	*Ardea herodias*
Mallard	*Anas platyrhynchos*
Black Duck	*Anas rubripes*
American Widgeon	*Mareca americana*
Red-Tailed Hawk	*Buteo jamaicensis*
Broad-Winged Hawk	*Buteo platypterus*
Osprey	*Pandion haliaetus*
Kestrel	*Falco sparverius*
Killdeer	*Charadrius vociferus*
Woodcock	*Philohela minor*
Wilson's Snipe	*Capella gallinago*
Spotted Sandpiper	*Actitis macularia*
Herring Gull	*Larus argentatus*
Mourning Dove	*Zenaidura macroura*
Flicker	*Colaptes auratus*
Downy Woodpecker	*Dendrocopus pubescens*
Crested Flycatcher	*Myiarchus crinitis*
Tree Swallow	*Iridoprocne bicolor*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
Crow	*Corvus brachyrhynchos*
Black-Capped Chickadee	*Parus atricapillus*
White-Breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
Robin	*Turdus migratorius*
Wood Thrush	*Hylocichla mustelina*
Veery	*Hylocichla fuscescens*
Starling	*Sturnus vulgaris*
Yellow Warbler	*Dendroica petechia*
Myrtle Warbler	*Dendroica coronata*
Yellowthroat	*Geothlypis trichas*
Red-Wing Blackbird	*Agelaius phoeniceus*

APPENDIX C

Surface Water Resources and Water Quality

NORTH HAVEN MALL

NORTH HAVEN, CONNECTICTUT



1981

US Army Corps of Engineers

New England Division

Appendix C

Surface Water Resources and Water Quality

The material contained in this appendix was prepared for Mall Properties, Inc., by Jason M. Cortell and Associates, Inc. It has been provided to the Corps of Engineers as information in support of application #13-79-561 for a permit under Section 404 of the Clean Water Act of 1977, and Section 10 of the River and Harbor Act of 1899.

SURFACE WATER RESOURCES
and WATER QUALITY

APPENDIX C

NORTH HAVEN MALL
North Haven, Connecticut

Prepared for:

MALL PROPERTIES INC.
New York, New York

Prepared by:

JASON M. CORTELL and ASSOCIATES INC.
Waltham, Massachusetts

August 1981

WALTHAM, MASSACHUSETTS • GLADSTONE, NEW JERSEY

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1.0 WATER QUALITY

1.1 Introduction

This report provides an examination of existing water quality in the major receiving surface water feature of the area - the Quinnipiac River - and documents the potential water quality impacts to the Quinnipiac River which may be anticipated as result of the construction and operation of the proposed North Haven Mall. Data from the Connecticut Department of Environmental Protection (DEP) and the United States Geological Survey (USGS) have been reviewed. Additionally, a site specific water quality analysis program was conducted to provide information about the site and specific impacts which may result from implementation of the project. The implementation of the proposed project will add to the base concentrations of certain elements in the Quinnipiac River. The project will not contribute to a significant increase in the overall organic and inorganic compounds in the River.

1.2 Water Quality Classification of the Quinnipiac River

From its source to the Southington Sewage Treatment Plant, the Quinnipiac River is presently classified by the Connecticut Department of Environmental Protection as Bc. This classification also represents the anticipated and adopted class for this segment of the River. From the Southington Treatment Plant downstream to tidewater, the River is classified as C. This classification also represents the anticipated and adopted class for this segment of the River. From the tidewater to the mouth of the River, the adopted classification is SB. In November, 1976, this segment of the River was classified as SD, while its anticipated November, 1979 classification was SC. The reach of the River at which the proposed mall would be constructed is classified as C. Such waters have good aesthetic value and are suitable for certain fish and wildlife habitat, recreational boating, and certain industrial processes and cooling. The specific criteria for each of the aforementioned classifications are contained in Attachment A.

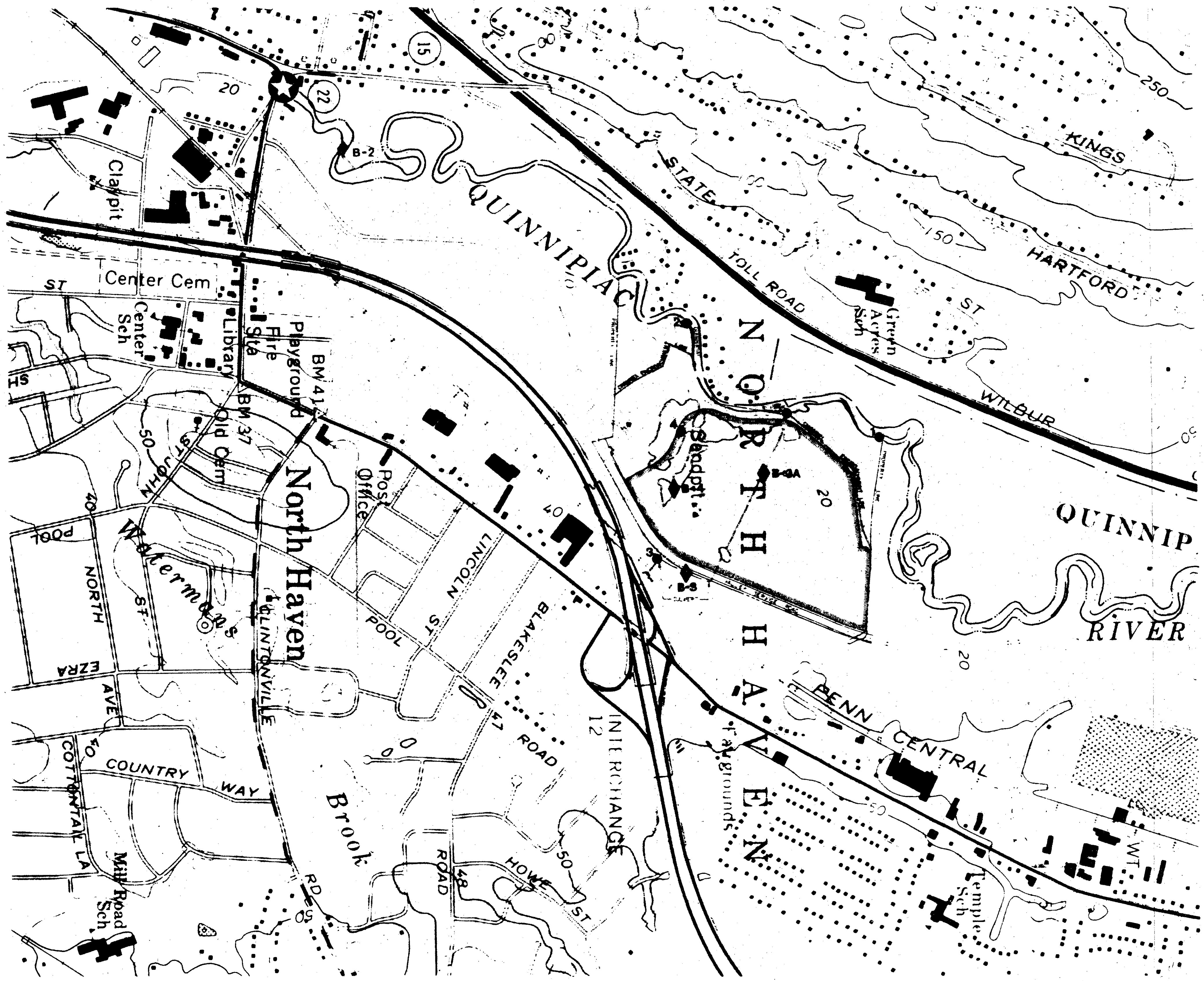
2.0 ENVIRONMENTAL SETTING

2.1 General River Water Quality

Water quality conditions in the Quinnipiac River have been monitored by the DEP and the USGS for chemical, microbiological, and biological components. The continuing USGS monitoring program commences at the upstream sampling location in Meriden and proceeds downstream through Wallingford to North Haven. The USGS sampling station at North Haven is located at the gaging station, as shown on Figure 1. Recent water quality data obtained from the USGS for the months of October through September of water year 1979 are contained in Attachment B (USGS, 1979). These data indicate that the River shows elevated nitrogen concentrations measured during all sampling periods. Likewise, total phosphorus levels are high. As noted in Attachment A, there are no water quality criteria for phosphorus, except for natural lakes, ponds, or their tributary surface waters. It should be noted that the Quinnipiac River south of the project is not a tributary to a natural lake or pond. The water is reasonably well buffered with circum-neutral pH levels maintained all year. Dissolved oxygen concentrations were within acceptable limits from October through June, but below the minimum limit for Class C waters of 4.0 mg/l from July through September. The lowest concentration was reported in July, 1979 at 2.2 mg/l. Such trace metals as copper and zinc have been found within the human health criteria of 1.0 mg/l and 5.0 mg/l respectively, cited by the U.S. Environmental Protection Agency (EPA) (1980). During March, the water quality data indicated the effects of winter storms preceding the March 12 sampling date. Such parameters as specific conductance, alkalinity, nitrogenous compounds, phosphorus, organic carbon, solids, and chloride all reflect considerable dilution at that time.

The Quinnipiac River basin is the site of large population and industrial centers which produce an effect on the quality of water in the River. A good description of drainage basin conditions can be found in the USGS publication Water Resources Inventory of Connecticut: Part 8, Quinnipiac River Basin, (Mazzaferro et al., 1979). The DEP reported (DEP, 1976) that the majority of the water quality problems in the River result from a number of sewage discharges from such municipal treatment facilities as Southington, Cheshire, Meriden, Wallingford, and North Haven. Twenty-five industrial plants discharge approximately 10.7 million gallons per day (gpd) of treated industrial wastewater. Over five million gallons of this amount is from the Upjohn and American Cyanamid Companies. The remainder originates from metal electroplating and steel mill operations. The above information is based upon a review of each National Pollution Discharge Elimination System (NPDES) permit holder for upstream discharges regarding type, volume, and quality of discharge (DEP - Water Compliance Unit, 1979).

Stormwater discharges occur along the River, discharging surface runoff from the industrial and urban centers. The combination of these discharges to the River has resulted in significant alterations of water quality conditions. Either on a diurnal or annual basis, erratic variations in solids, nutrients, and most notably, dissolved oxygen, have been documented. The DEP and USGS



LEGEND:

- SITE
- LIMITS OF DEVELOPMENT
- SURFACE WATERS
- 1 WATER QUALITY SAMPLING STATIONS
- B-2 AQUATIC BIOLOGICAL SAMPLING STATIONS
- USGS GAGING STATION

SOURCE: JASON M. CORTELL AND ASSOCIATES, INC. 1979 & 1980

MALL PROPERTIES INC.
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NORTH HAVEN MALL
VALLEY SERVICE ROAD
NORTH HAVEN, CONNECTICUT

WATER QUALITY AND AQUATIC BIOLOGICAL SAMPLING STATION LOCATIONS

400 200 0 400 800 1200

SCALE	
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CHECKED BY	J E A
JOB NO	2819
DRAWING NO	FIGURE - 1

have reported instances when dissolved oxygen levels have fallen to levels below the 4.0 mg/l minimum during summer months. The diurnal cycle in oxygen production by vegetation and respiration of oxygen by plants, animals (Biochemical Oxygen Demand (BOD)), and bacteria, is reason for the variation. These problems were reported through September, 1979.

In general, no major trend in water quality is obvious from the past five years of data collected by the USGS at their North Haven sampling location at the gaging station (See Figure 1). To improve conditions nearby in Cheshire, a tertiary treatment plant is planned. It is expected that the nutrient and BOD reductions in the effluent will appreciably improve conditions in the upstream reaches.

Bacteriological conditions monitored by the USGS have been found to be quite high. During the period from October 1 through April 30, disinfection is not required of municipal sewage treatment facilities. While the USGS data for this period indicates that bacteria were very high, no corrective actions are taken to reduce the input. During the summer months when treatment plant effluents must receive disinfection, considerable variation can be noted from one year to the next in concentrations of total coliform bacteria. In general, the waters at North Haven do not meet the required microbiological standard for Class C waters. During the summers of 1975 and 1976, the criteria were exceeded. During 1978, only the June sample indicated acceptable conditions and the May and July samples in 1977 indicated acceptable bacteriological conditions. Bacteriological conditions were acceptable throughout the summer of 1979.

Water quality indications through biological conditions in the Quinnipiac River have been documented as part of the DEP's compliance monitoring program (Jason M. Cortell and Associates Inc., (JMCA), 1976). The results of a three time per year for two years monitoring effort indicate that the aquatic organisms found in the River are those tolerant to facultative in relation to degraded water quality. The monitoring program obtained data on the major aquatic communities to include phytoplankton, periphyton, benthic macroinvertebrates, zooplankton, and finfish. The following discussion on biological conditions is considered representative of present conditions in the river.

> "Based on the analysis of the biological communities of the Quinnipiac River, the water is enriched and most generally in a mesosaprobic state. Although the phytoplankton density has been low on most occasions, the presence and abundance of Navicula and Scenedesmus indicates organic and nutrient enrichment. The diversity of the phytoplankton community was variable, and this variability is believed to be due to the presence of periphyton species which have been torn from the substrate, and the occasional presence of lentic forms washed into the stream. During the summers of 1974 and 1975, the rotifer Brachionus was abundant at the Wallingford and North Haven stations. This rotifer is found in lentic and lotic (Hynes, 1970) systems. In this instance, it is possible

its production occurred in quieter reaches of the River where flow rate is reduced, Hanover Pond (part of the River) or possibly from some other waterbody. This organism is also found in alpha to beta mesosaprobic zones.

During both years of monitoring, the periphyton community consistently indicated moderate levels of enrichment and mesosaprobic conditions. This is true for the stations from Southington to North Haven. There were some variations in the density of the indicator organisms from one station to the next and seasonally; however, the net indications were the same. The major indicator organisms found during the monitoring are: Lyngbya, Oscillatoria, Cocconeis, Cyclotella, Navicula, Nitzschia, Gomphonema, Surirella, Fragilaria, Achnanthes, Asterionella, and Synedra. The macroinvertebrate community also adds further substantiation. In pooled reaches of the river which were sampled ... during periods when riffles were inaccessible ...; pollution tolerant midge larvae and Limnodrilus were found. Whenever riffles contained gravel sized particles or larger were sampled, organisms considered to be tolerant or facultative/intolerant were found. The more common species were the caddisflies Hydropsyche and Cheumatopsyche which are faculative/intolerant. Riffles, however, are the only areas where the caddisflies and faculative mayflies have been found. Intolerant organisms were not uncovered at any station on the river. Inasmuch as the caddisflies and mayflies were only found in fast flowing areas where water movement over gills could render conditions more tolerable, and intolerant species were not found, the areas sampled are considered to contain mesosaprobic conditions with organic and nutrient enrichment. The fish sampling yielded only tolerant and faculative species at all areas. Many of the fish were also found to have finrot disease and other infestations. Trout are stocked in the spring at Quinnipiac Gorge (just downstream from Station 5); however, summer survival is doubtful. White suckers were particularly abundant upstream of Station 5. Sparse to moderate amounts of elodea, pondweeds, cattails, arrowhead, waterlily, and smartweed were observed. Dissolved oxygen saturation levels varied and at times were as low as 55 percent" (JMCA, 1976).

More recent samples of the benthic community were collected at locations indicated on Figure 1 on April 3, 1980. Sampling locations included both the Quinnipiac River and the twin 84 in. culvert located just east of the site, and onsite water features, which include the Connecticut Department of Transportation (DOT) drainage ditch and the pond located in the southcentral portion of the site. The results of the sampling and identification are contained in Attachment C. As has been found in previous work on the Quinnipiac River, pollution tolerant worms were the dominant organisms. Several pupae of the pollution sensitive horsefly Tabanus, nematodes, and beetles were also present in the Quinnipiac River sample. Of the four stations sampled during this study, the location on the Quinnipiac River was found to contain the second most diverse benthic community. In relation to other streams in the State, the diversity, however, is considered moderate. The substrate was composed of septic smelling organic silt.

At Sampling Station B-3 on the upper portion of the DOT drainage ditch, amphipods (Gammarus fasciatus) were very abundant, occupying 98 percent of the sample. This animal is ubiquitous and most frequently found in areas where detritus and vegetation are prevalent on the substrate. The substrate at this location was composed of sand with detritus, filamentous algae, and other organic material. The Shannon Weiner diversity of 0.5 was the lowest of all the sampled communities and is attributable to the high proportion of the amphipods.

Very few organisms were found at Station B-3A. This may indicate the physical limitations placed on biota in the drainage ditch either by spates and the opposite condition of extreme low flows. Although no-flow conditions have been found at the twin 84 inch culverts at water Sampling Station 3, the drainage ditch has not been found dry. Flows have been found to be very low in both volume and velocity, however. The benthic community was found to be moderately diverse.

Conditions in the pond at sampling location B-4 were indicative of organic enrichment in that all organisms found in the sample are considered facultative and/or tolerant of organic pollution. These includes tolerant worms, tolerant and facultative snails, caddisflies, and facultative and intolerant midges. The community was found to be the most diverse of the four sampled.

The ponds on the site have been found to support warm water species of fish and provide a spawning area for anadromous fish. From onsite observations and interviews with fishermen, the following warm water fish are known to inhabit the ponds.

Goldfish	Carassius auratus
Carp	Cyprinus carpio
Largemouth Bass	Micropterus salmoides
Eel	Anguilla rostrata
Bluegill Sunfish	Lepomis macrochirus
Black Crappie	Pomoxis nigromaculatus
Minnows	

Since white suckers (Catostmus commersoni) are ubiquitous, it is very likely that the site also contains a dense population of these fish.

During field investigations in the months of April and May, 1980, the migration of either alewife (Alosa pseudoharengus) and/or blueback herring (Alosa aestivalis) was observed. Samples of the fish could not be obtained by which to ascertain a species-specific identification. The fish were present during two observation periods, one in each month. The fish were noted in the Ponds and migrating up the DOT drainage ditch. Since both species annually migrate into freshwater streams and ponds for spawning, it is assumed that the onsite water features are providing sufficient habitat for reproduction of these fish.

The Connecticut Department of Environmental Protection (Donald Mysling, DEP, 1980, Personal Communication) reports the Quinnipiac River has an anadromous fishery principally consisting of alewife, blueback herring, menhaden (Brevoortia tyrannus), shad (Pomolobus mediocris), white perch (Morone americana), striped bass (Morone saxitilis), Atlantic silverside (Menidia menidia), and sea run brown trout (Salmo trutta). The alewife, blueback herring, menhaden, and white perch are known to enter the Quinnipiac River. However, the latter species may only be found in small numbers, if at all (Donald Mysling, DEP, 1980, Personal Communication). The fish presently migrate to the Wallace Company dam located approximately 1,500 ft south of Community Lake in Wallingford (James McCrea, New England River Basins Commissions, 1981, Personal Communication).

The condition of the biological community near the mouth of the Quinnipiac River between I-91 and Ferry Street in New Haven was monitored for the DEP during 1974, 1975, and 1976. The following discussion relating to this area is considered representative of present conditions.

> "The marine station on the Quinnipiac River (Station 8, New Haven) is also contaminated with organics and nutrients, however, solid indicator species were not found. The best indication is the lack of sensitive species. During the summer, blooms of diatoms were noted. Spring and fall phytoplankton samples were of moderate densities and dominated by diatoms or dinoflagellates. Zooplankton densities were variable but on many occasions dominated or co-dominated by ciliates and Crustacea. Larval forms were generally sparse, perhaps due in part to the time of sampling. While the periphyton density varied from one sample period to the next, reliable indicator organisms were always present. Such algal species as Lyngbya, Ulothrix, Cyclotella, Asterionella, Navicula, Surirella, Achnanthes, and Nitzschia consistently indicated the presence of moderate levels of oxidizable organics and nutrient enrichment. During the first year of monitoring, barnacles were the most abundant macroinvertebrate found. During the second year, substrate stratified sampling continued to yield large quantities of barnacles from mud and sand areas. Mud snails were also found on both substrates. A bed of soft shelled clams was found on the sand substrate. While the organisms found are tolerant of pollution, none of them have a narrow range of tolerance but may be found in cleaner areas as well. The sediment in other downstream areas of the river was found to be so anoxic that no biota was present. Although bluefish and some flounder are reported in this reach, no fish were captured in the trawls. The use of a gill net and/or seine at low tide may be a more appropriate sampline method. The most commonly found vascular plants and macroscopic algae were Zostera marina and Ulva lactuca" (JMCA, 1976).

It should be noted that during the aforementioned study, a large population of soft shelled clams was found between I-91 and the bridge at Grand Avenue in the City of New Haven. Also, the substrate near the Ferry Street bridge, downstream of the Grand Avenue bridge, contained putrescent mud with accumulations of petroleum residues and hydrogen sulfide. Recently, the CT Department of Agriculture - Aquaculture Division has reported a considerable oyster seed crop above the Grand Avenue bridge (Baker, 1980). The location of this seed crop was confirmed by Mr. Ed Wong of the U.S. EPA. However, Mr. Wong indicated that its occurrence was spotty, the reasons for which are unknown (Ed Wong, U.S. EPA, 1980, Personal Communication).

2.2 Site Specific Water Quality Conditions

2.2.1 Normal Flow Water Quality

To facilitate assessments of probable water quality impacts from the proposed mall construction and operation, five water quality sampling stations were established at locations indicated on Figure 1. Sample Station 1 was located at the north boundary of the site on the Quinnipiac River. Sample Station 2 was located on the south border of the property, also on the Quinnipiac River. Between these two sampling locations, there is a major surface water input from an unnamed watercourse which carries runoff from Interstate Route 91, Route 5, and other local roadways and residential areas. The water from this drainage area is conveyed through the site in the a drainage channel constructed by the Connecticut Department of Transportation (DOT), which is shown in Figure 1. Water enters the Quinnipiac River between Stations 1 and 2. At the request of U.S. EPA Region I office, additional sampling and analyses were also conducted at the end of the DOT drainage ditch, immediately before it enters the Quinnipiac River. This sampling was conducted under normal flow conditions in May, 1980. Water quality in the ponds was also sampled and analyzed during April, 1980. Water quality analyses were conducted for a number of parameters; some are indicative of general water quality and others are useful in solute balance computations in the assessment of probable water quality impacts. The parameters for which analyses were conducted were approved by the U.S. EPA (1980). The results of these analyses are contained in the water quality data sheets (Attachment D).

Handling and preservation procedures contained in the Manual of Methods for Chemical Analysis of Water and Wastes, 1979, were followed. The laboratory analyses followed procedures presented in the following manuals:

Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, 1975.

Manual of Methods for Chemical Analysis of Water and Wastes, Environmental Protection Agency, 1979.

1979 Annual Book of ASTM Standards, Part 31, Water, ASTM, 1979.

Handbook for Analytical Quality Control in Water and Wastewater Laboratories, Environmental Protection Agency, 1979.

The subsequent discussion of existing water quality is based on the data obtained from sampling efforts and the comparison of these data to the U.S. EPA (1976 and 1980) and USGS (1980) water quality criteria, as well as the Connecticut Water Quality Standards (1980).

Results of analyses conducted on samples collected on August 10, 1979 and April 23, 1980 at Stations 1 and 2 indicate the water in the Quinnipiac River had a slightly murky appearance and an amber color. The water has had a septic odor on most sampling occasions. The waters were well buffered (they can withstand addition of acid ions without drastic changes in pH) with circum-neutral pH levels. Hardness concentrations (85.8 - 101.4 mg/l of $CaCO_3$) indicate the water is moderately hard as classified on the Durfor and Becker scale. Chloride concentrations were relatively low (22.1 - 28.5 mg/l) and consistent with concentrations reported by the USGS for other periods and locations. Iron was found to be present at relatively moderate concentrations (0.48 - 0.66 mg/l) with potential sources being natural geological conditions as well as industrial facilities along the River and urban runoff. The sodium concentrations were considerably higher (12.8 - 20.8 mg/l) than one would expect given the concentration of chloride and suggest the implication of sources other than roadway de-icing salts. Ammonia, nitrate, and Kjeldahl nitrogen concentrations were found to be elevated (0.15 - 1.08 mg/l, 2.0 - 3.4 mg/l, and 2.9 - 7.6 mg/l, respectively) with the most probable contributors being the municipal sewage discharges upstream of the sampling locations. Total phosphorus was also found at high concentrations (0.28 - 0.84 mg/l) and its most likely sources are the municipal treatment plant discharges. Although there was a difference in oil and grease concentrations between the two sampling locations, the 3.6 mg/l found at Station 2 on August 10, 1979 is not considered to be of significant level since similar concentrations can be found in natural waters from biogenic decay. Phenol concentrations were generally within limits cited by the U.S. EPA (1976) and the USGS (1980). During the August 1979 sampling, a considerable difference was found in dissolved oxygen concentrations between the upstream station (Station 1) where 9.0 mg/l was found and the downstream location (Station 2) where 6.0 mg/l of oxygen was found. The cause(s) for the difference is not known. BOD, COD, and solids data were within levels expected for the River and are consistent with water quality data from the USGS for the Wallingford and North Haven sampling locations. Fecal coliform bacteria were found to be within the 2,500 bacteria per 100 ml maximum standard for Class C waters during August, 1979. However, in April, 1980 when disinfection is not required of discharges, the bacteriological concentrations were very high (3,200 - 4,000 per 100 ml). With respect to fecal coliform bacteria, the compliance of a surface water with State water quality standards is actually based on data collected from more than one sample (See Attachment A). Thus, the above-mentioned and subsequent comparisons of sampling results for fecal coliform with State standards are not an actual determination of the status of the surface water. The information presented does, however, serve as an indication of bacteriological conditions during the sampling period. Regarding metal concentrations for Stations 1 and 2, as well as each of the remaining sampling locations, Tables 1 through 5 provide a comparison of sampling results for various metals with water quality criteria established by the U.S. EPA (1980).

Table 1

COPPER CONCENTRATION WITH RESPECT TO
U.S. EPA WATER QUALITY CRITERIA

Sample Station No. and Date of Sample	Concentration (mg/l)		
	Sample Station	Criteria	
		Human Health	Freshwater Aquatic Life*
1			
8/10/79	0.02	1.00	0.019
9/6/79	0.06	1.00	0.010
4/23/80	0.02	1.00	0.017
2			
8/10/79	0.02	1.00	0.019
4/23/80	0.01	1.00	0.017
3			
9/3/79	0.01	1.00	0.005
9/6/79	0.01	1.00	0.003
4/23/80	0.02	1.00	0.006
4			
4/23/80	0.01	1.00	0.012
5			
5/8/80	0.03	1.00	0.018

*According to the U.S. EPA, the criteria for freshwater aquatic life are not to be exceeded at any time. These criteria are to be considered by the CT DEP but are not binding upon that State agency (See CT DEP Water Quality Standards, General Policy 11). Criteria concentrations are based on the total alkalinity of the sample and are rounded off to three decimal places.

Table 2

LEAD CONCENTRATION WITH RESPECT TO
U.S. EPA WATER QUALITY CRITERIA

Sample Station No. and Date of Sample	Concentration (mg/l)		
		Criteria	
	Sample Station	Human Health	Freshwater Aquatic Life*
1			
8/10/79	0.05	0.05	0.140
9/6/79	0.05	0.05	0.061
4/23/80	0.005	0.05	0.121
2			
8/10/79	0.05	0.05	0.139
4/23/80	0.005	0.05	0.120
3			
9/3/79	0.05	0.05	0.027
9/6/79	0.05	0.05	0.012
4/23/80	0.005	0.05	0.029
4			
4/23/80	0.005	0.05	0.076
5			
5/8/80	0.03	0.05	0.130

*According to the U.S. EPA, the criteria for freshwater aquatic life are not to be exceeded at any time. These criteria are to be considered by the CT DEP but are not binding upon that State agency (See CT DEP Water Quality Standards, General Policy 11). Criteria concentrations are based on the total alkalinity of the sample and are rounded off to three decimal places.

Table 3

NICKEL CONCENTRATION WITH RESPECT TO
U.S. EPA WATER QUALITY CRITERIA

Sample Station No. and Date of Sample	Concentration (mg/l)		
	Sample Station	Criteria	
		Human Health	Freshwater Aquatic Life***
1			
8/10/79	0.02	0.0134* 0.100**	1.621
9/6/79	0.02	0.0134* 0.100**	0.966
4/23/80	0.009	0.0134* 0.100**	1.479
2			
8/10/79	0.02	0.0134* 0.100**	1.617
4/23/80	0.009	0.0134* 0.100**	1.473
3			
9/3/79	0.02	0.0134* 0.100**	0.584
9/6/79	0.02	0.0134* 0.100**	0.354
4/23/80	0.005	0.0134* 0.100**	0.614
4			
4/23/80	0.005	0.0134* 0.100**	1.109
5			
5/8/80	0.007	0.0134* 0.100**	1.552

*For the protection of human health from the toxic properties of nickel ingested through water and contaminated aquatic organisms.

**For the protection of human health from the toxic properties of nickel ingested through contaminated aquatic organisms alone.

***According to the U.S. EPA, the criteria for freshwater aquatic life are not to be exceeded at any time. These criteria are to be considered by the CT DEP but are not binding upon that State agency (See CT DEP Water Quality Standards, General Policy 11). Criteria concentrations are based on the total alkalinity of the sample and are rounded off to three decimal places.

Table 4

SILVER CONCENTRATION WITH RESPECT TO
U.S. EPA WATER QUALITY CRITERIA

Sample Station No. and Date of Sample	Concentration (mg/l)		
		Criteria	
	Sample Station	Human Health	Freshwater Aquatic Life*
1			
8/10/79	0.01	0.05	0.003
9/6/79	0.01	0.05	0.001
4/23/80	0.01	0.05	0.002
2			
8/10/79	0.01	0.05	0.003
4/23/80	0.01	0.05	0.001
3			
9/3/79	0.01	0.05	0.0003
9/6/79	0.01	0.05	0.0001
4/23/80	0.01	0.05	0.0003
4			
4/23/80	0.01	0.05	0.001
5			
5/8/80	0.01	0.05	0.003

*According to the U.S. EPA, the criteria for freshwater aquatic life are not to be exceeded at any time. These criteria are to be considered by the CT DEP but are not binding upon that State agency (See CT DEP Water Quality Standards, General Policy 11). Criteria concentrations are based on the total alkalinity of the sample and are rounded off to three decimal places.

Table 5

ZINC CONCENTRATION WITH RESPECT TO
U.S. EPA WATER QUALITY CRITERIA

Sample Station No. and Date of Sample	Concentration (mg/l)		
	Sample Station	Criteria	
		Human Health	Freshwater Aquatic Life*
1			
8/10/79	0.02	5.0	0.028
9/6/79	0.04	5.0	0.158
4/23/80	0.02	5.0	0.252
2			
8/10/79	0.02	5.0	0.278
4/23/80	0.02	5.0	0.251
3			
9/3/79	0.02	5.0	0.091
9/6/79	0.02	5.0	0.053
4/23/80	0.03	5.0	0.096
4			
4/23/80	0.02	5.0	0.184
5			
5/8/80	0.02	5.0	0.266

*According to the U.S. EPA, the criteria for freshwater aquatic life are not to be exceeded at any time. These criteria are to be considered by the CT DEP but are not binding upon that State agency (See CT DEP Water Quality Standards, General Policy 11). Criteria concentrations are based on the total alkalinity of the sample and are rounded off to three decimal places.

Sample Station 3, located at the twin 84 in. culverts on the east portion of the property, did not have water flowing during the August 10 sampling period. Instead a sample was collected on September 3, 1979 and April 23, 1980 and analyzed for the same parameters as Stations 1 and 2. Turbidity and color values indicated the water at Station 3 was considerably clearer than water in the Quinnipiac River. The water had a moderate buffering capacity with a slightly acidic pH level (6.0 - 6.7). The water was moderately hard (64.0 - 67.0 mg/l of $CaCO_3$). The water showed high chloride concentrations of 82.0 mg/l and 49.6 mg/l, two to three times higher than water in the Quinnipiac River. It is an indication of the effect of de-icing salts used on the local roadways, Route 5, and Interstate Route 91. The sodium level (23.5 - 31.0 mg/l) was also higher than that in the Quinnipiac River. While the ammonia nitrogen concentration (0.06 - 0.11 mg/l) was within limits cited by the U.S. EPA (1976), there was a relatively high concentration of nitrate nitrogen (1.3 - 3.2 mg/l). Based on limits cited by the U.S. EPA (1976) and the USGS (1980), Kjeldahl nitrogen level (0.58 - 1.0 mg/l) was considered moderate. Given the nature and amount of development in the drainage system to this watercourse, the nutrient levels, including phosphorus, are considered the normal effects of an urban environment and its drainage waters. Oil and grease and phenol levels were close to or below detectable limits. Dissolved oxygen was found to be quite acceptable according to Class C standards, i.e., 11.0 - 15.0 mg/l. Likewise, both BOD and COD were within normal limits (1.9 - 3.8 mg/l and 7.1 - 7.5 mg/l, respectively). Total coliform bacteria were high with a concentration of 12,800/100 ml during September, 1979. They were much lower (250/100 ml), however, during April, 1980. Fecal coliform and fecal streptococci bacteria were also high (3,000/100 ml and 5,600/100 ml, respectively) during September, 1979, yet the fecal coliform/fecal streptococci ratio did not suggest human wastes as the source. It is not uncommon for urban and roadway drainage to contain high bacterial loads and the finding of such bacteria in this water is regarded as a typical constituent of urban drainage.

Water quality at Sample Station 4 between the two ponds was determined on April 23, 1980. The water was reasonably clear with some turbidity and color. A good buffering capacity was found with the pH slightly alkaline (7.8). The water was moderately hard (57.2 mg/l of $CaCO_3$). The water in the Ponds contained considerably less iron, calcium, and sodium than did the Quinnipiac River. The ammonia content of the water (0.02 mg/l) was within limits cited by the U.S. EPA (1976). However, the nitrate and Kjeldahl nitrogen concentrations were high (2.8 mg/l and 3.2 mg/l, respectively). Total phosphorus was also high (0.11 mg/l) and the overall nutrient content of the water indicates the Ponds are enriched and eutrophic. Oil and grease and phenol concentrations were at detection limits. The water contained 13.0 mg/l of dissolved oxygen at noon. The moderate amount of algae and plant growth in the pond (based on field observations) combined with a cool water temperature (14 C) are believed to be the principle reasons for the presence of dissolved oxygen at 125 percent saturation. The 13.0 mg/l of dissolved oxygen is not considered indicative of severe diurnal oxygen production and respiration sags. BOD was slightly elevated (5.1 mg/l). COD concentrations were low (7.7 mg/l).

Suspended solids were slightly higher in the Ponds than in the Quinnipiac River. However, the dissolved solids and specific conductance were lower in the Ponds. These variations are reasonable. It is assumed that when the ponds were sampled in April, 1980, they contained seasonally high amounts of water and thus had higher levels of suspended solids, most likely composed of amorphous materials, silts, and algae. In the river, the higher dissolved solids and specific conductance may be attributed to the continuous influx of wastewater. Bacteriological concentrations were within Class C standards.

Water quality at Sample Station 5, located at the mouth of the DOT drainage channel, was found to be similar to that in the Quinnipiac River (as compared to conditions at either Station 1 or 2). Water at Sample Station 5 is derived, in part, from back water from the Quinnipiac River, urban drainage coming downstream in the DOT drainage ditch, as well as outflow water from the Ponds. As such, turbidity, alkalinity, pH, oxygen demands, most of the trace metals (calcium was found to be approximately 57 percent higher than the next closest concentration of calcium in the Quinnipiac River) were of similar concentration when compared with each of the water sources. Kjeldahl nitrogen was found to be higher (5.5 mg/l) than all other locations sampled during the month of April. However, considerably higher concentrations have been found in the Quinnipiac River during previous sampling periods. Inorganic nitrogen and phosphorus concentrations indicate the water was enriched. Fecal coliform bacteria were found to be within Class C standards, though total coliform bacteria was elevated (disinfection, however, was not required of upstream dischargers at the time of sampling).

2.2.2 Water Quality of Storm Flows

To provide an indication of the quality of flows in the Quinnipiac River at Station 1 and the tributary at Station 3 during a storm, two samples were collected while Hurricane David passed through the region on September 6, 1979. The samples were collected approximately twenty minutes after the heavy rain started. The stormwater runoff entering the River north of Station 1 produced a doubling of turbidity in the Quinnipiac River (from 9.0 mg/l to 18.0 mg/l) while turbidity was reduced in the water at Sample Station 3 by dilution (from 2.0 mg/l to 0.6 mg/l). Alkalinity concentrations were diluted at both stations while pH remained essentially unchanged. Chloride concentrations nearly doubled in the Quinnipiac River (from 28.5 mg/l to 50.8 mg/l) while at Station 3, there was dilution (from 82.0 mg/l to 77.1 mg/l). A striking contrast to normal flow conditions was found in sodium concentration in the Quinnipiac River with a near ten fold increase (from 20.8 mg/l to 195.0 mg/l). Whether or not this condition with sodium is typical of storm events cannot be determined due to the lack of historical data.

In comparison to other heavy metals contained in roadway runoff during storm conditions, iron was found at highest concentrations (0.81 mg/l at Station 1 and 0.10 mg/l at Station 3). The values measured in the runoff on September 6 also indicated that iron was present in the water at higher than dry weather concentrations. At Station 1, iron concentrations increased from 0.66 to 0.81 mg/l while at Station 3 the concentration of iron increased from 0.08 to 0.10 mg/l.

With respect to roadway runoff at Station 3, the nitrogen compounds (ammonia, nitrate, and Kjeldahl) were found to be present at higher concentrations in the water of the Quinnipiac River. During storm flow conditions at Station 1, ammonia, nitrate, and Kjeldahl were found at concentrations of 1.8 mg/l, 3.6 mg/l, and 8.8 mg/l, respectively. At Station 3, the concentrations of these parameters were 0.09 mg/l, 1.6 mg/l, and 0.88 mg/l, respectively. The phosphorus concentration in the River nearly doubled (from 0.84 mg/l to 1.35 mg/l). Additionally, the dissolved oxygen (6.0 mg/l) was found to be within Class C standards. BOD was found to increase by a factor of two to three at Stations 3 and 1, respectively while COD in the River decreased. Total and dissolved solids in the Quinnipiac River showed a near ten fold increase in concentration (from 227.1 mg/l to 2,048.0 mg/l of total solids and from 210.0 mg/l to 2,034.0 mg/l dissolved solids). Also associated with the increase of dissolved solids was a fifty fold increase in specific conductance (from 325 MHOS/cm to 18,100 MHOS/cm). Total coliform bacteria increased dramatically at both sampling stations. At Station 1, total coliform bacteria increased from 1,600 to 225,000 per 100 ml while at Station 3 it increased from 12,800 to 345,000 per 100 ml.

2.3 Transportation Modification Areas

Existing drainage channels and the Quinnipiac River constitute the only surface water features associated with the proposed transportation modification areas. No surface waters exist in the vicinity of Mall Drive. However, drainage channels are located immediately adjacent to Valley Service Road and the site of the proposed jughandle.

The water quality of the Quinnipiac River downstream of the proposed project site opposite Valley Service Road and the proposed jughandle area is expected to be consistent with that found in the upstream sample stations (See Section 2.2). Additionally, based on an examination of land use surrounding the transportation modification areas, it is anticipated that the quality of water relative to the above-mentioned drainage channels is similar to that recorded for Sample Station 3 (See Section 2.2).

A sample of the benthic community of the Quinnipiac River adjacent to Route 5/22 was collected on April 3, 1980. The results of the sampling and identification are given in Attachment C; a discussion of the benthic community in this area is presented in Section 2.1

3.0 ENVIRONMENTAL IMPACTS

During the useful life of a facility such as the North Haven Mall, there are two periods during which impacts to water quality may originate. These include the construction of the facility, and its operation and maintenance.

3.1 Water Quality Impacts Associated with Construction

Excavation and fill activities at the project site can be conducted without significant impacts to water quality. Due to the present location of onsite surface waters, construction activity can be generally sequenced from upstream to downstream. As a result, impacts regarding sedimentation would be effectively reduced (See Appendix D - Sediment and Erosion Control for the specific sequence of construction). The implementation of the Sediment and Erosion Control plan will also reduce construction-related impacts to the Quinnipiac River.

The excavation and expansion of the southernmost pond on the site can be accomplished with little impact to the River since the area to be excavated is not on an actively flowing water course and it can be isolated from the River. Subsequent to isolating the project site from the River, surface water will be led in a southerly direction through each of the ponds onsite allowing for the settlement of sediment. A specific sedimentation and erosion plan has been prepared by Raymond Keyes Engineers, PC, in accordance with the "Erosion and Sediment Control Handbook for Connecticut (1976)."

3.2 Water Quality Impacts Associated with Operation and Maintenance

In determining potential impacts to water quality from operation and maintenance of a mall, or roadway, the preferred methodology is to compute a solute balance. The general equation is:

$$C_3 = \frac{C_1Q_1 + C_2Q_2}{Q_1 + Q_2}$$

where

Q_1 = volume of flow of runoff,
C_1 = concentration of solute in runoff,
Q_2 = volume of dilution water (receiving water),
C_2 = concentration of solute in receiving water, and
C_3 = final concentration observed.

The approach to evaluation of the potential impacts is generally of a conservative nature. As a worst case analysis, no reduction of the contaminants is assumed through settling and aeration either in the drainage system or the pond. All dust and dirt associated parameters are assumed to be contributed totally to the water with no removal through pavement sweeping.

Adequate discharge and precipitation information is available on the Quinnipiac River and the region to satisfy the Q parameters. The USGS reports the runoff for the period of record on the Wallingford gauge is 2.14 ft. The Mazzaferro et al. (1979) report states that the regional precipitation is 3.95 ft per year. Connecticut DEP reports the Q_{7-10} flow volumes to be 20.5 cfs at the USGS gage in Wallingford (approximately 4.5 river miles from the proposed detention pond outlet). Q_{7-10} is the 7 consecutive day 10 year low flow. All steady state modeling for point source discharges is based on this flow and represents a worst case analysis. With these data, river and onsite water flows may be readily computed. The drainage basin area of the Quinnipiac River upstream of the proposed point of discharge of water from the tributary at Sampling Station 3 and mall drainage is 124 mi^2 (Raymond Keyes Engineers, PC, 1979). The tributary drainage at Station 3 is approximately 800 acres of which approximately 75 acres is paved. This 75 acres is composed of 12,500 ft of Interstate 91, 8,000 ft of Route 5, and other associated local roadways (Raymond Keyes Engineers, PC, 1979).

3.2.1 Literature Sources of Runoff Quality Data

Data required for quantification of the loading of contaminants from traffic is taken from literature sources. There are a number of reports on the subject of traffic and roadway associated loadings. However, specific data for mall type of land use and local-data are sparse. In 1974, Amy et al. published a report for the EPA on "Water Quality Management Planning for Urban Runoff." In that report, loading rates for a number of parameters were presented in pounds per curb mile per day for solids and associated parameters. These data were determined for several climatological areas of the nation and various land uses. Later, Shaheen (1975) reported the polluting characteristics of runoff from a variety of roadway usages in and around Washington, DC. Again, the study was based on the chemical parameters associated with roadside dust and dirt and not actual water quality measurements. It is the only major source of data, however, which contains loading information specific to mall land use and forms the data base used to compute the solute balance equations for the North Haven Mall project (See Table 6). Another source of data is a report by Smullen et al. (1978) which contains information on extractable lead, extractable zinc, total phosphorus, total nitrogen, and COD. This is a useful baseline study since it involved a large number of storm runoff measurements for various land uses including a shopping center. The loading rates from the Smullen Report are also utilized in this North Haven Mall report (Table 7). It should be pointed out that the location for Smullen's study was Fairfax, Virginia. The results of another useful study are available in a report published by Mattraw (1978). The principle drawback to these data is geographic location since the work was conducted in Fort Lauderdale, FL.

The loading rates from both Shaheen (1975) and Smullen et al. (1978) were used to compute the solute balance equations for the proposed North Haven Mall. As noted in Tables 6 and 7, each of these studies, for the most part, addresses different parameters. Additionally, Shaheen's data are presented in terms of

Table 6

LOADING RATES FOR PARKING LOT CONTAMINANTS

Parameter	Loading/axle-mile/day*	Axle-miles/day**	Total Daily Load	Daily Load in Pond Catchment***	Daily Load in H.W.D.-1 Catchment***
Lead	7.700×10^{-5} lbs	89,600	6.90 lbs	5.45 lbs	1.45 lbs
Copper	1.693×10^{-6} lbs	89,600	0.16 lbs	0.13 lbs	0.03 lbs
Nickel	3.328×10^{-6} lbs	89,600	0.30 lbs	0.24 lbs	0.06 lbs
COD	5.965×10^{-3} lbs	89,600	534.40 lbs	422.20 lbs	112.20 lbs
Fecal Streptococci* (No. of Organisms)	7.520×10^{7}		3.76×10^{8}	2.97×10^{8}	7.90×10^{7}
Nitrate	2.148×10^{-6} lbs	89,600	0.20 lbs	0.16 lbs	0.04 lbs
TKN	3.920×10^{-5} lbs	89,600	3.6 lbs	2.84 lbs	0.76 lbs
Grease	5.280×10^{-4} lbs	89,600	47.2 lbs	37.29 lbs	9.91 lbs
Volatile Solids	6.077×10^{-3} lbs	89,600	544.0 lbs	430.0 lbs	114.0 lbs

*Loading rate is per curb mile; loadings based on 5 curb miles for the project.
**Source: Barkan and Mess (1980) - See Section 3.2.2
***Catchment refers to the drainage area (watershed) of the detention pond and the H.W.D.-1 outfall (See Section 3.2.3).

Based on Shaheen (1975)

Table 7

ANNUAL LOADING RATES FOR PARKING LOT CONTAMINANTS
(lbs)

Parameter	Loading/acre/year	Loading in Detention Pond Catchment	Loading in H.W.D.-1 Catchment
Chemical Oxygen Demand	927.00	54,137.00	16,037.00
Lead	2.53	147.70	43.77
Zinc	2.92	170.50	50.52
Phosphorus	1.93	112.70	33.39
Nitrogen	27.50	1606.00	475.75

Based on Smullen *et al.* (1978)

daily loading rates. The data from Smullen et al. are presented in terms of annual loading rates. Thus, the use of data from both reports allows for the assessment of potential impacts associated with a greater number of parameters during various periods of time.

The Regional Planning Agency of South Central Connecticut is presently conducting a Section 208 water quality program. However, the program has not yet included wet weather sampling from land uses similar to that of the proposed North Haven Mall. In the wet weather water quality survey from the Northern Middlesex Area Commission in Massachusetts (Massachusetts Division of Water Pollution Control, 1977), runoff data have been monitored for three periods which coincide with winter (December, 7, 1976); spring (May 9, 1977); and summer (July 25, 1977). The monitoring was conducted at the stormwater outfall from an industrial facility and the runoff included parking area, access roadways, maintained grassed areas, and roofing. The data from this source are used for determining suspended solids loads from the proposed North Haven Mall. As part of the Mercer County, New Jersey, 208 Water Quality Planning Program (Mercer County Planning Division, 1980), the Water Resources Research Institute at Rutgers University sampled a stormwater outfall from the Lawrence Shopping Center in Lawrence, New Jersey on two occasions. While these data are of limited use in establishing a modeling base, they can be used for comparative purposes (See Section 3.2.3).

Short term impacts to water quality from a paved area are storm related and are particularly concentrated in the first flush. This condition is demonstrated in Figures 2 through 6. The data for the Figures were generated by Jason M. Cortell and Associates Inc. for the New Jersey Department of Transportation. Figures 2 through 6 demonstrate the loading of runoff water with various contaminants during a storm. Note the impact of the first flush and the later return to more typical water quality. Iron concentrations, for example, were so high that they were off the scale used for the heavy metals, peaking at over 5.0 mg/l in the first flush. Because of the difference in travel of traffic on the interstate roadway in New Jersey versus the North Haven Mall, it is more appropriate to use Shaheen and Smullen data rather than open roadway runoff data, such as those given in Figures 2 through 6 for New Jersey.

3.2.2 Traffic Data

Barken and Mess Associates, Inc. (1979) have projected the daily traffic entering and exiting the Mall may be 21,000 vehicles and Saturday traffic may be 28,000 vehicles entering and leaving the facility. It has been determined that the average vehicle travels one mile into and out of the Mall from the main routes. The potential traffic associated contaminants have been determined and are presented in Table 6. The time averaged value of 89,600 axle miles per day is the anticipated traffic volume upon which the traffic related impacts are based. The axle mile per day value of 89,600 is a volume weighted number.

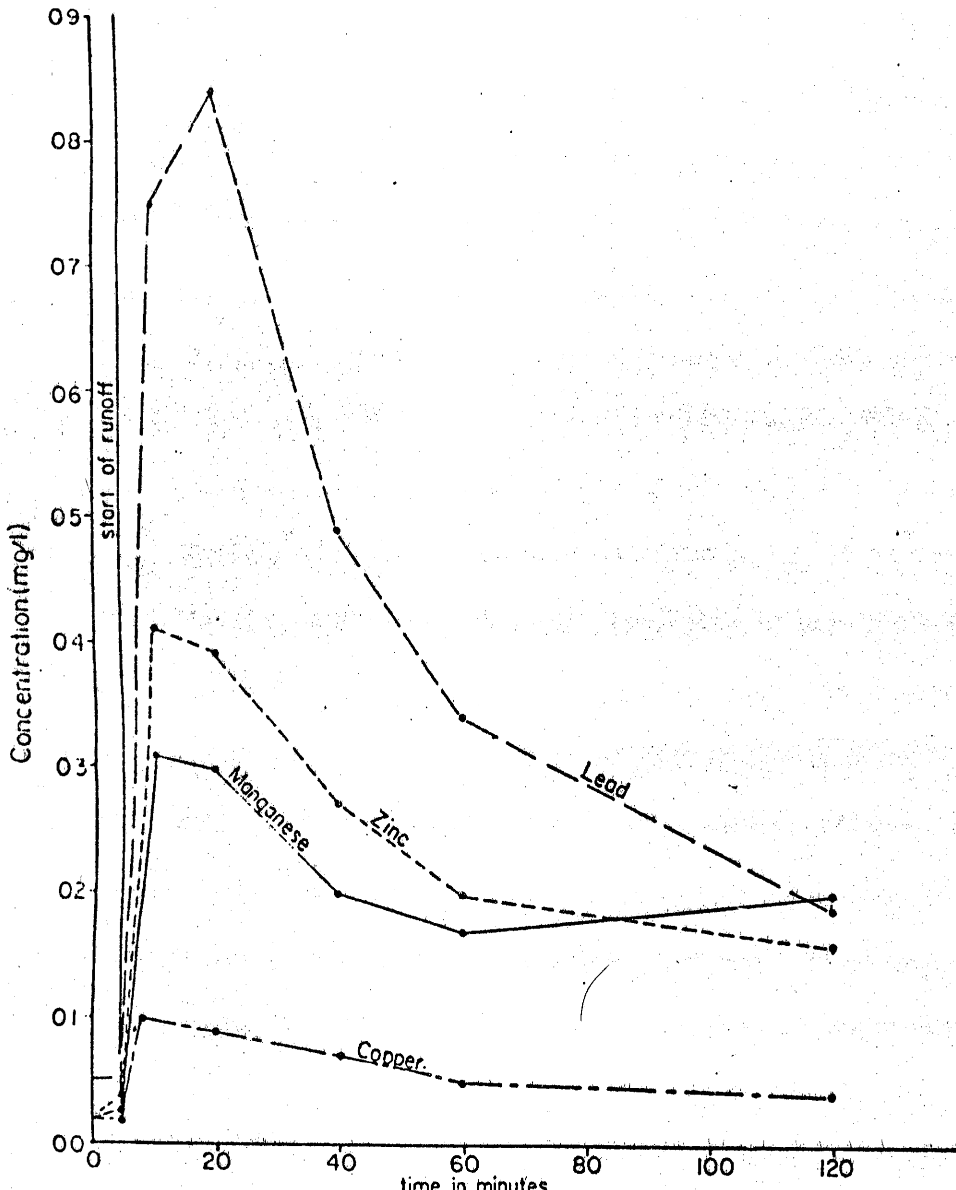


Figure 2 Trace Metals in Runoff from I-287 at Stelton Road
October 26, 1977

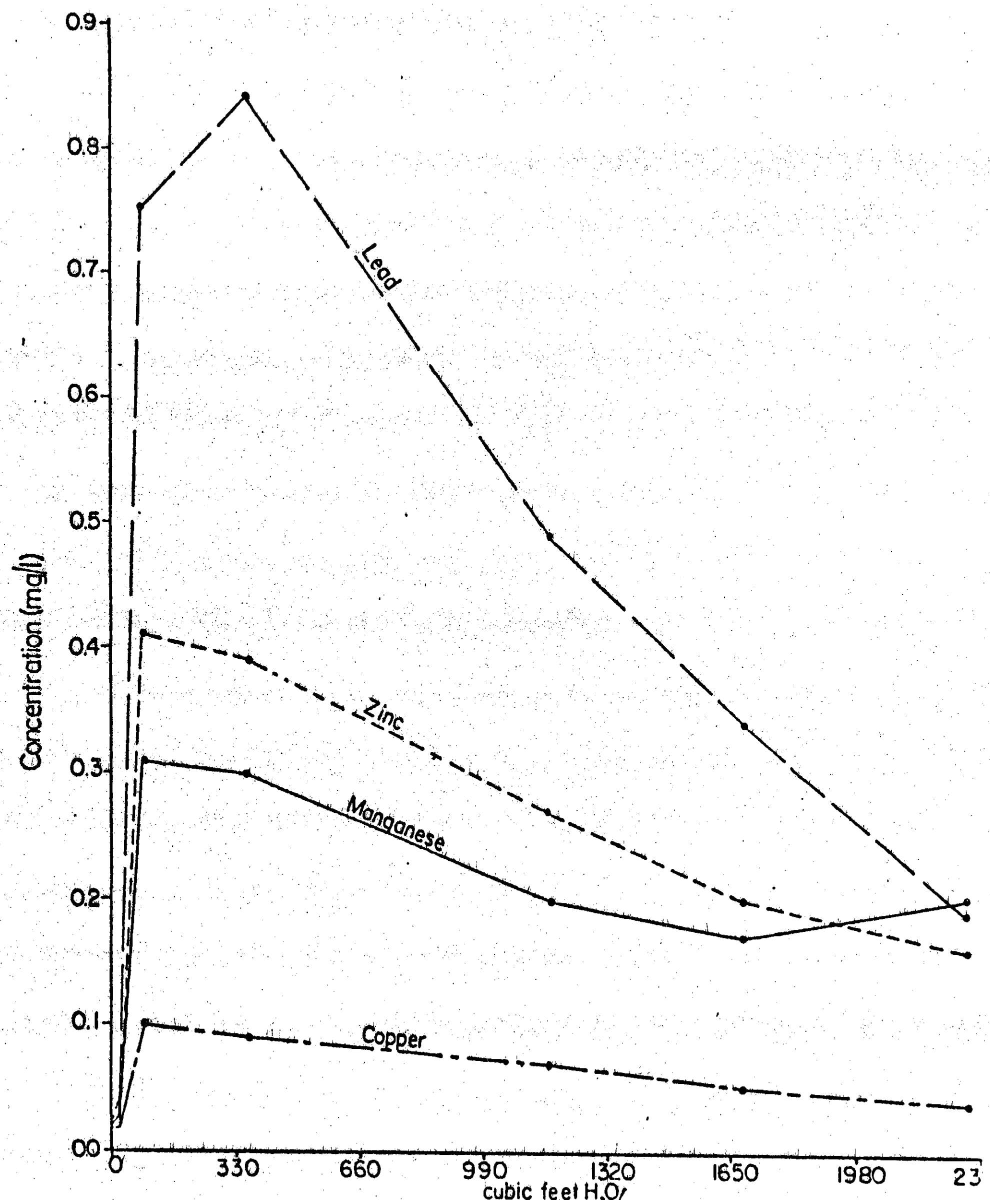


Figure 3 Trace Metals in Runoff from I-287 at Stelton Road
October 26, 1977

Source: Jason M. Cortell and Associates Inc. 1979

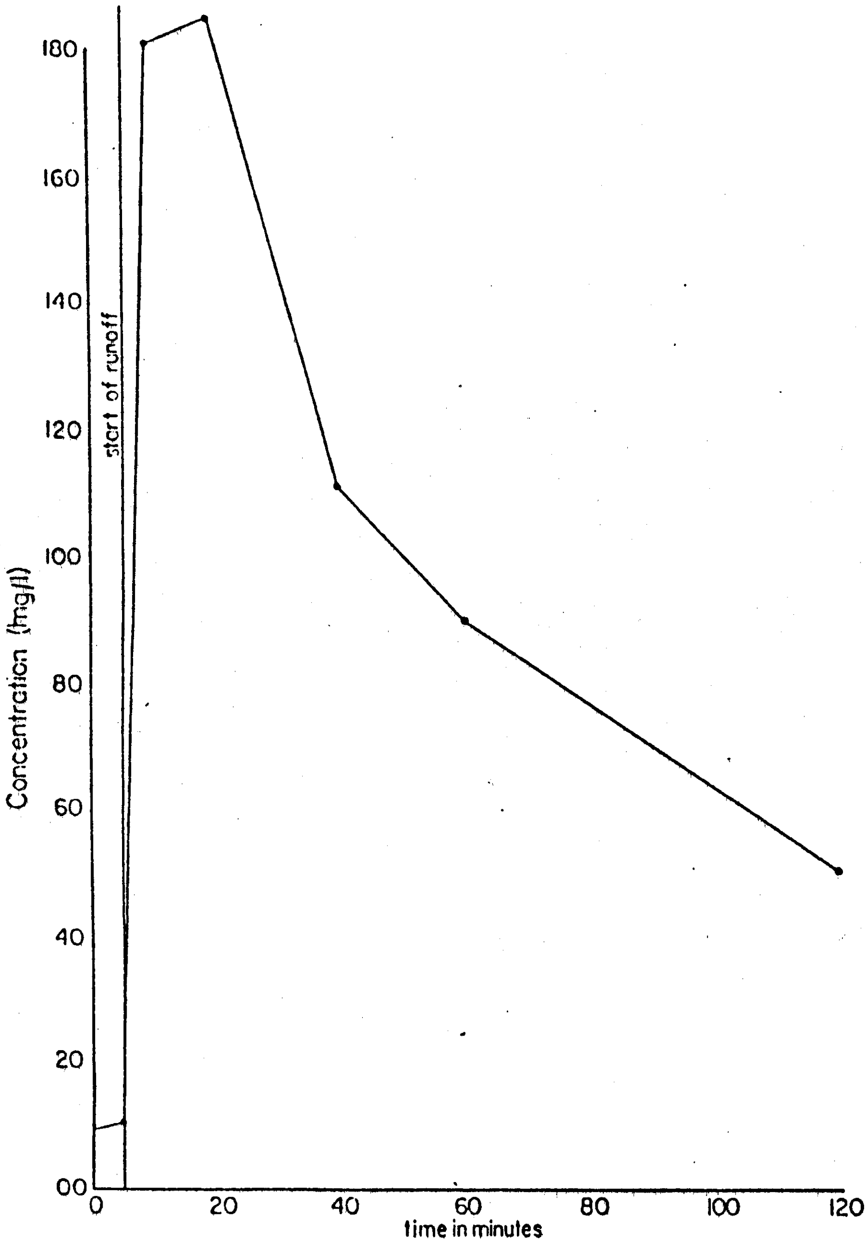


Figure 4 COD in runoff from I-287 at Stelton Road
October 26,1977

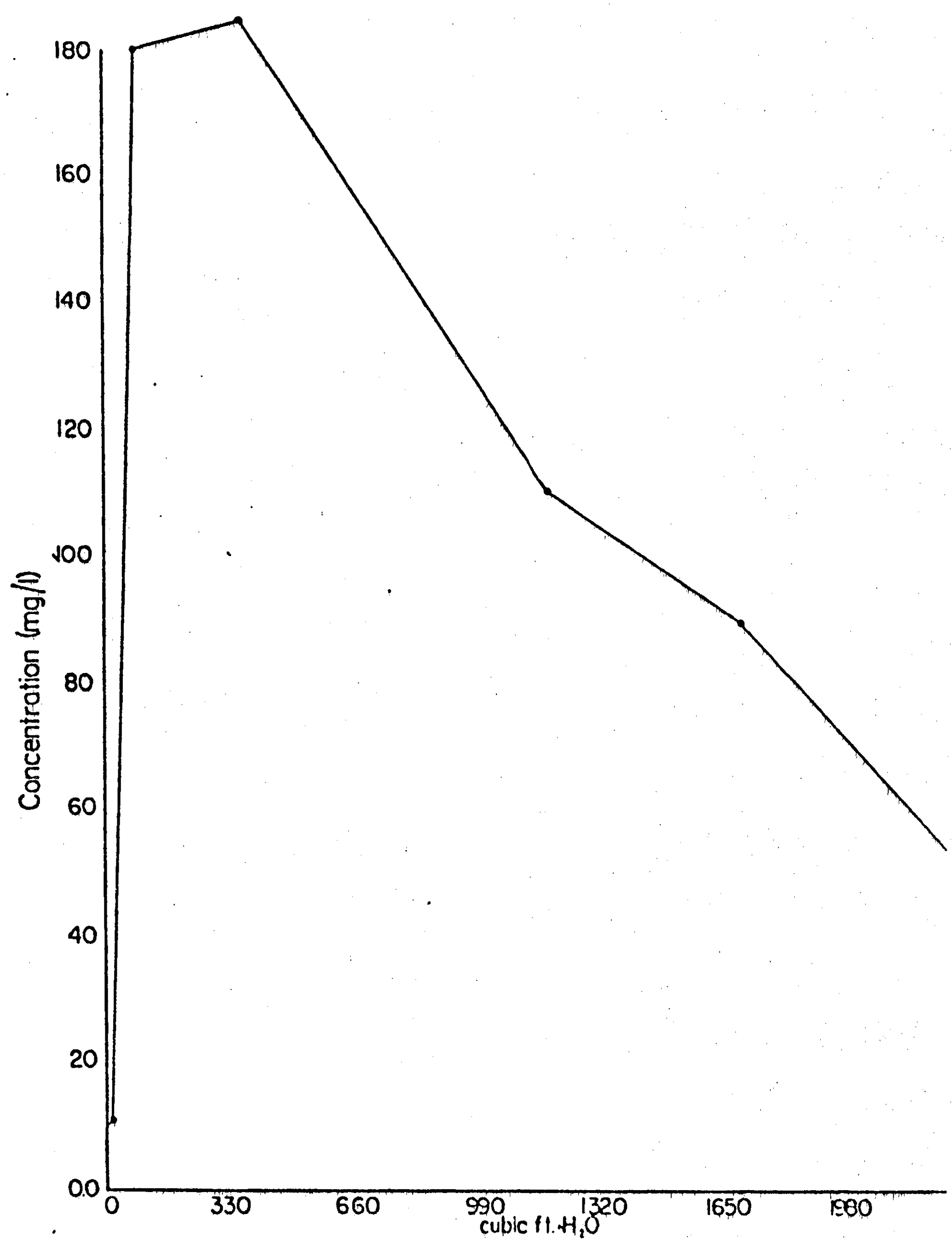
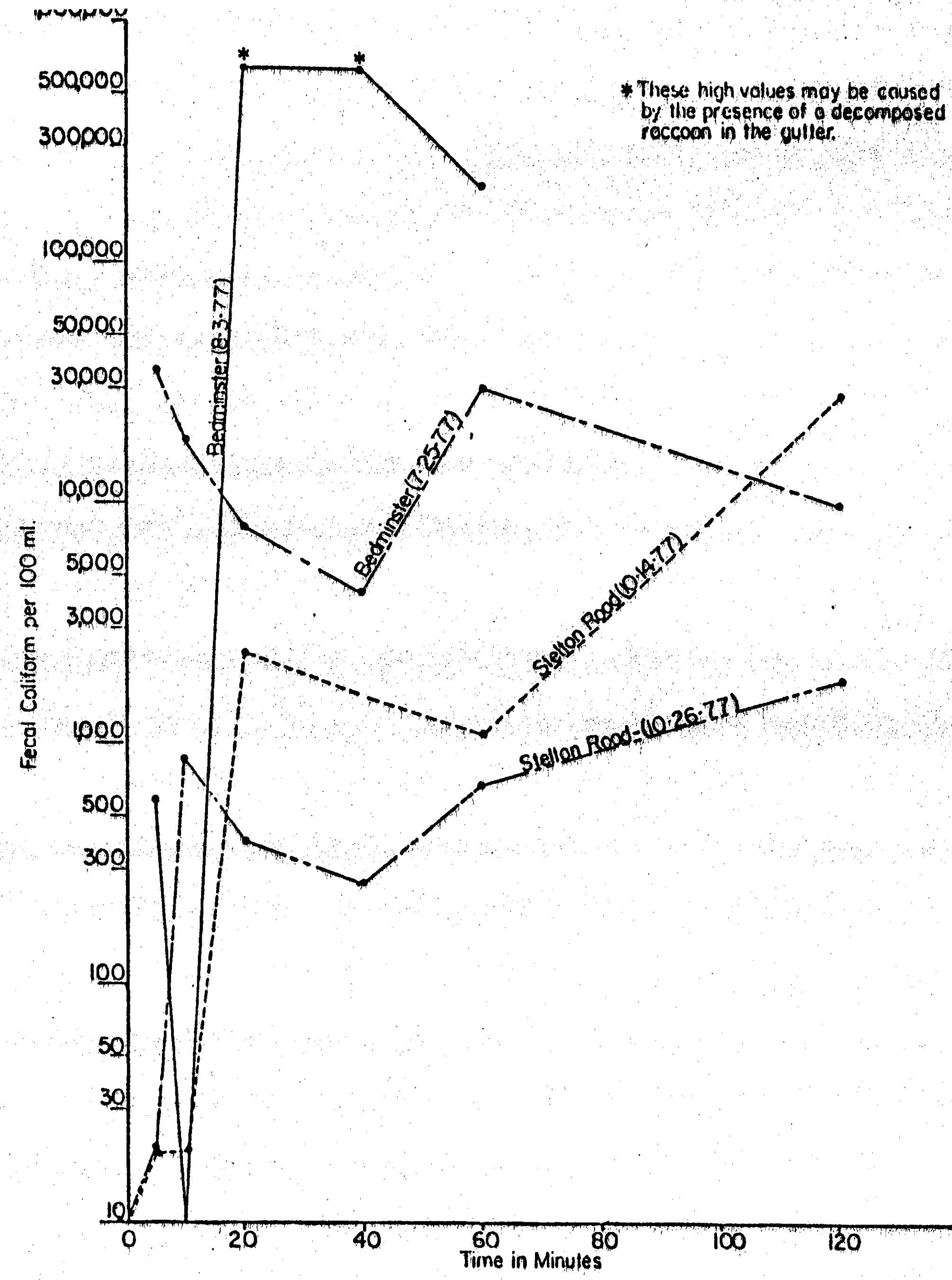


Figure 5 COD in runoff from I-287 at Stelton Road
October 26,1977

Source: Jason M. Cortell and Associates Inc. 1979



Summary of Fecal Coliform in Highway Runoff Figure 6

Source: Jason M. Cortell and Associates Inc. 1979

3.2.3 Impact Assessments

Laxen and Harrison (1977) report that loading of a pavement surface with traffic associated contaminants progresses for approximately three days in a linear manner and then becomes asymptotic. There are others (Gupta et al., 1977) who report loading continues linearly between storm events. Therefore, the loading of water with these contaminants has been computed for a three day period as well as on an annual basis. The length of time during which accumulation of traffic-associated pollutants take place linearly is referred to as the three-day period. After this time, Laxen and Harrison (1977) report accumulations level off. The information is included to provide a short-term analysis of runoff impacts to water quality. Annual refers to computations based on one year of traffic at the Mall, with the resultant traffic-associated pollutants discharged into the respective receiving water with a diluting volume based on an average annual discharge. The discharges were extrapolated from the USGS gage in Wallingford. The potential water quality impacts during periods when Q_{7-10} conditions are present have also been determined.

The proposed North Haven Mall is designed so that stormwater drainage is conveyed to two areas of discharge or outfall. One area which encompasses approximately 25 percent of the total hard surface area is to discharge directly to the Quinnipiac River (this outfall is referred to as H.W.D.-1, and is located in the northwestern portion of the site at the present westerly terminus of the DOT drainage channel). The balance of the site (75 percent of pavement and roofing) is to discharge into the detention pond through which all local drainage will also pass. The detention pond will then discharge into the River. The data presented in Table 6 and the resulting concentrations of traffic-associated contaminants presented in Table 8 are based on the total dust and dirt loadings from Shaheen (1975). Shaheen's study was based on the chemical parameters associated with roadside dust and dirt and not actual water quality measurements of stormwater runoff. As a result, Shaheen's values would be higher than would be expected from parking lot runoff and offer a conservative worst case estimate.

The runoff data from Smullen et al. (1978) are considered closest to actual conditions. The loadings have also been determined for each of the two major catchments or drainage areas (the detention pond and the H.W.D.-1 outfall) on the Mall property (Table 7) and the resulting quality of water at the base of each catchment has been estimated (Table 9).

The estimated water quality concentrations presented in Tables 8 and 9 for both the detention pond and the H.W.D-1 outfall are within ranges found by others for shopping centers (Mercer County Planning Division, 1980) and highways (Gupta, 1978). The massed loadings and the potential impact to the Quinnipiac River on an annual basis are indicated in Table 10.

The tabulations indicate an increase of contaminants in the drainage water before it enters the Quinnipiac River. This is attributable to the land use upstream of the proposed site and the resultant quality of the water flowing past Sample Station 3, and the low volume of diluting water in the DOT drainage channel. Once this water enters the Quinnipiac River, there is

Table 8

RESULTING CONCENTRATIONS OF TRAFFIC ASSOCIATED CONTAMINANTS
(mg/l)

Parameter	Concentration in						
	Detention Pond				H.W. D-1 Outfall		
	Background Water*	3 day	Q_{7-10}	Annual	3 day	Q_{7-10}	Annual
Lead	0.05	0.06	0.08	0.05	0.10	0.23	0.03
Copper	0.01	0.04	0.07	0.01	0.20	0.47	0.06
Nickel	0.02	0.07	0.14	0.02	0.40	0.94	0.12
COD	7.20	97.10	216.90	7.53	752.11	1,754.90	231.90
Fecal Streptococci	13,160.00	14,550.00	16,410.00	13,165.00	11,700.00	27,300.00	3,600.00
Nitrate	1.60	1.63	1.68	1.60	0.27	0.63	0.08
TKN	0.88	1.48	2.29	0.88	66.43	155.00	20.51
Oil and Grease	0.10	8.00	18.60	0.13	5.09	11.88	1.57

Note: Assumed 100% soluble except for lead which is 1% soluble (Pitt and Amy, 1973) and shown at a factor of 0.01 of solid loading rate of 7.70×10^{-5} lb/ax-mi/day.

*Wet weather data at Sample Station 3

Based on Shaheen (1975)

Table 9

RESULTING ANNUAL CONCENTRATION OF RUNOFF ASSOCIATED CONTAMINANTS (mg/l)

Parameter	Concentration in		
	Background Water*	Detention Pond	H.W.D-1 Outfall
Chemical Oxygen Demand	7.20	7.32	90.93
Lead	0.05	0.05	0.25
Zinc	0.02	0.02	0.29
Phosphorus	0.06	0.06	0.19
Nitrogen	2.57	2.48	2.70

Based on Smullen et al. (1978)

* Wet weather data at Sample Station 3

Table 10

IMPACTS OF MASSED CONTAMINANTS TO THE QUINNIPIAC RIVER
(mg/l)

Parameter	Background Water*	3 day and Q_{7-10}	Annual
Lead	0.05	0.06	0.05
Copper	0.06	0.06	0.06
Nickel	0.02	0.02	0.02
COD	15.00	15.20	15.40
Fecal Streptococci	1,150.00	1,620.00	1,156.00
Nitrate Nitrogen	3.60	3.60	3.60
TKN	8.80	8.80	8.80
Grease	0.70	0.74	0.74
Zinc	0.04	0.04	0.04
Phosphorus	1.35	1.35	1.35

* Wet weather data at Sample Station 1

adequate dilution to make very little difference between average background conditions and the resulting concentration when the Mall is operational.

The project would result in a small addition of contaminants to the present base load of the Quinnipiac River. However, because of the diluting effect of the Quinnipiac River, the project would not contribute to a significant increase in the overall organic and inorganic compounds in the River.

3.2.4 Suspended Solids

The impact analysis for the North Haven Mall project in relation to suspended solids involves two areas of interest, the loss of onsite storage volumes and operational impacts. A portion of the site presently serves as a flood plain not only for floods induced by storm events but also for seasonally related runoff events. Raymond Keyes Engineers, PC has estimated the seasonal water storage volume of the site (site storage based upon the 2 year flood event) prior and subsequent to development to be approximately 3.55 and 2.06 million cubic feet respectively. Seasonal flooding generally takes place during March and April. The storage capacity of the site may be compared with the monthly discharge for these months with the resultant observation that for water year 1979, the storage/discharge relation was such that during March, the site stored approximately two-tenths of one percent of the monthly discharge of the River. In April, if flooding were to last all month, the site would store three-tenths of one percent of the monthly River discharge. Following site development, the project area would store approximately one-tenth of one percent of the March discharge and two-tenths of one percent of the April discharge of the Quinnipiac River.

The suspended sediment load in the River is approximately 1,485 tons during March and 636 tons during April. Based on the conservative assumption that the maximum suspended solids levels found in the River are also found in water on the site, it has been determined that the site can presently store two-tenths of one percent (approximately 3 tons) of the monthly March sediment load and one-half of one percent (approximately 3.2 tons) of the monthly April load. Subsequent to site development, the capacity of the site for storage of River sediment would be approximately one-tenth of one percent in March and three-tenths of one percent in April.

The loss of the small storage capacity for settleable solids subsequent to Mall development would not impact any of the resources downstream in the River or New Haven Harbor (See Section 3.3).

The contribution of suspended solids to ambient levels in the Quinnipiac River during construction will be less than presently occurs, and will be negligible. As detailed in Appendix D - Sediment and Erosion Control, existing soil erosion will be reduced on the project site both during construction and subsequent to project completion. Rather than eroded material dispersing in a more or less random fashion as presently occurs, most of it (75 percent) will be directed to the detention pond. The diversion of most of the surface runoff to the detention pond would allow for the settlement of sediment prior to discharge to the Quinnipiac River. The efficiency of the site in controlling suspended solids would also be augmented by other sediment and erosion controls. Thus, suspended solids concentrations entering the Quinnipiac River from the project site would not affect either the water quality of the River or its aquatic flora and fauna.

3.2.5 Winter Deicing Impact

A solute balance of impacts associated with winter deicing was also conducted. The worst case condition assumed that all the parking area of 62 acres would be salted with an application rate reported by the Connecticut Department of Transportation of 0.15 tons per two lane miles (Connecticut Department of Transportation: 1978). This would be equivalent to 1.90 tons of chloride which, when diluted with an average volume of water originating during the months of November through March, could raise the average chloride concentration in the detention pond and Quinnipiac River by approximately 2.0 mg/l and less than 1.0 mg/l, respectively. The impact to water quality from deicing on an annual basis is less, with a potential increase of chloride of less than 1.0 mg/l in the detention pond and the Quinnipiac River. Such increases would have a minimal impact on the overall water quality of the Quinnipiac River.

The ecology of the stormwater detention pond will be subject to typical limnological variations. During the summer, the pond will stratify physically and chemically. Surface waters will be warmed to 20 - 24^{o}C and a thermocline will develop at a depth of approximately 10 - 12 ft. A thermocline refers to the layer in a thermally stratified body of water within which the temperature decreases rapidly with increasing depth. The area of water above the thermocline is called the epilimnion, while the water layer below the thermocline constitutes the hypolimnion. Salt (chloride) accumulation within the detention pond hypolimnion during the winter and its potential mixing into the epilimnion during turnover has also been assessed in terms of impact. This assessment included only that portion of the detention pond's catchment (drainage area) to be salted, i.e., the parking lot, and was conducted by means of a mass balance simulation of salting during the normal winter. The route of salt through the catchment and the detention pond with the appropriate diluting steps was subsequently analyzed.

During a normal winter (based on National Oceanic and Atmospheric Administration weather records), approximately 1.4 tons of chloride would be applied to pavement surfaces within the pond catchment. This salt would be transported from the pavement surface to the pond by normal precipitation events, yielding a chloride concentration in the runoff water of approximately 18.0 mg/l. The runoff into the hypolimnion (the volume of which is approximately 9.4 million ft^3), results in a chloride concentration of 4.0 mg/l above background conditions. As the chloride mixes with the epilimnion during spring turnover, a chloride concentration of 2.0 mg/l above background in the detention pond may result. Neither the chloride concentrations of the runoff water in the hypolimnion, nor the fully mixed pond endanger fish. Pavement salting, therefore, is not expected to inhibit the survival, reproduction, or growth of fish including anadromous species.

3.2.6 Summer Temperature Impact

Summer runoff from the roadway parking surfaces may be several degrees higher in temperature, possibly as much as 5 degrees, than other runoff water. The warmer water condition will be limited to the first flush and may endure for 10 to 15 minutes after which much cooler water will lower the temperature. The long culvert travel distance and detention of the runoff in the detention pond will also allow for a considerable loss of heat through mixing of cooler waters before entering the Quinnipiac River. In the northwest portion of the site where runoff will be diverted directly to the Quinnipiac River, temperature-related impacts will be limited by the smaller volume of runoff in this area and the diluting effect of the Quinnipiac River.

3.3 Biological Impacts

The construction of the North Haven Mall will result in the mortality of aquatic organisms which cannot avoid the placement of fill in those areas to be filled. The projeet would also result in the partial loss of onsite spawning areas for anadromous fish such as the herring species which are now known to migrate into the site. However, to minimize the biological impacts, the outlet works for the detention pond have been designed to provide a dual role in that they will allow for continued access by fish to the pond as well as function as a stormwater detention facility. The specific recommended plan is contained in Appendix E - Stormwater Management.

As previously noted, the ecology of the stormwater detention pond will be subject to typical limnological variations. During the summer, the pond will stratify physically and chemically and a thermocline will develop at a depth of approximately 10-12 ft. A cool hypolimnion will be found in the detention pond during the summer in which generally anaerobic conditions will develop. The volume of aerobic water within the epilimnion will provide more habitat for fish than is found at present. This is due to the expansion of the existing onsite surface waters. Conditions within the epilimnion will not hinder the reproduction and growth of fish, including anadromous species.

The invert of the outlet structure from the detention pond into the Quinnipiac River is approximately 7 - 9 ft above the estimated level of the thermocline. Therefore, under ordinary circumstances, little or no potential exists for anaerobic water to enter the Quinnipiac River from the hypolimnion of the detention pond. The only circumstance under which this could happen would be a severe storm involving a complete turnover and the incomplete reoxygenation of pond waters. When the water column undergoes destratification in the fall, there would also not be an introduction of anaerobic water to the River unless the event is combined with a severe storm event.

When lakes and ponds turn over, the thermocline is gradually lowered into the hypolimnium and mixing of anaerobic hypolimnetic waters does not result in severe oxygen depression in the epilimnion. Thus, aquatic communities associated with the Quinnipiac River are not expected to be affected by the functioning of the detention pond.

Water entering the pond will be enriched and will contain nutrients for the growth of algae. In the spring, diatoms will be the dominant species, as they are in other ponds. During the summer, green and bluegreen algae will be present. The growth of algae, however, would be controlled by the rapid flushing rate of the pond (computed from USGS data from the Wallingford gaging station). In an average summer, the pond would flush approximately 0.75 times each month. This is a very high flushing rate in comparison to the flushing rates of many lakes and ponds whose flushing is measured in years. The algae growth in the pond, therefore, would be controlled by flushing and would not be cause for malodors or unsightly appearances.

Water quality impacts associated with the operational phase of the North Haven Mall are not expected to result in conditions that would detrimentally alter the River's aquatic communities.

The existing biota in the vicinity of the Grand Avenue Bridge and upstream to the project site will not be adversely affected by the construction and operation of the proposed facility. It has been estimated that the proposed project would contribute approximately 5.0 mg/l of suspended solids to the Quinnipiac River. This actually represent a reduction in the site's contribution of suspended solids relative to existing site conditions. Thus, the proposed project will not cause any effects beyond those associated with existing conditions in relation to soft shell clams or oysters downstream. Based on the Sediment and Erosion Control Plan, the project site's contribution of suspended solids to the Quinnipiac River will be less during construction and subsequent to project completion than under existing conditions. The resulting maximum concentration of 115 mg/l in the River (maximum suspended solids in April, 1977 as reported by the USGS plus 5 mg/l) is considerably less than the conditions reported by Davis and Hidu (1969) where the organisms were found to tolerate induced turbidity of generally up to 1,000 mg/l. Tsai et al., (1979) reported the 96 hour LC_{50} for the soft shell clam was 137,200 mg/l suspended solids. Therefore, 5 mg/l of suspended solids above background conditions is not expected to have an adverse impact to the existing fauna of the Quinnipiac River or New Haven Harbor.

3.4 Transportation Modification Areas

Along Valley Service Road and the proposed jughandle south of the project site, roadway runoff will be directed via drainage channels to the Quinnipiac River. However, because of the relatively small surface area (less than approximately 3.5 acres) to be covered by impervious material in relation to existing conditions, increases in the concentrations of roadway-associated contaminants introduced to the Quinnipiac River would be small. As a result, the impacts to water quality and aquatic biology are too small to quantify.

The surface runoff from Mall Drive and that portion of the Valley Service Road constituting site frontage will drain via drainage channels and pipes to the detention pond. The relatively small surface area to be covered with impervious material relative to existing conditions will not significantly alter the concentrations of contaminants in the drainage water before it enters the Quinnipiac River from the detention pond.

3.5 Cumulative Impacts

To assess the cumulative impact of the proposed project in relation to surface water and water quality, a variety of public agencies responsible for permit review and approval were contacted for information relative to recently approved and pending building permits for construction along the Quinnipiac River from Wallingford to New Haven, CT. These agencies included the CTDEP regarding Wallingford and New Haven, and the Towns of North Haven and Hamden.

According to the information obtained from these agencies, a total of approximately 110 acres associated with 21 separate projects along or within close proximity to the Quinnipiac River are subject to potential development. To provide a conservative estimate of potential impacts to water quality, the assumption is made that all 110 acres would be involved in developments which could, in some manner, impact water quality. Additionally, the assumption that the loading rates from Smullen (1978) for strip commercial developments would be applicable is utilized. The massed loadings from the above developments, therefore, together with the development of the North Haven Mall, could result in the following maximum cumulative increases above background water quality in the Quinnipiac River:

COD	0.39 mg/l above background
Lead	0.002 mg/l above background
Zinc	0.001 mg/l above background
Phosphorus	0.001 mg/l above background
Nitrogen	0.009 mg/l above background

Given the unavailability of various data regarding those areas subject to potential development, a precise account of aquatic biological impacts is not possible. It may be assumed that the construction of these projects would result in similar impacts as outlined for the proposed North Haven Mall, i.e. the mortality of aquatic organisms unable to avoid construction activities and/or the loss of spawning areas for anadromous fish. However, it is anticipated that the construction and operation of these projects, along with the proposed North Haven Mall, would not result in the significant alteration of the water quality or aquatic communities associated with the Quinnipiac River.

3.5.1 Secondary Development - Commercial/Office/Residential

Cumulative impacts may also occur from secondary development resulting from the construction and operation of the North Haven Mall. According to

Appendix L - Economic and Land Use Impacts of the North Haven Mall, secondary commercial development is most likely to occur along Washington Avenue and the east side of Valley Service Road. Any additional office space is likely to occur only along the east side of Valley Service Road.

Commercial growth along Washington Avenue would probably be limited to the expansion of existing community shopping facilities and the more efficient utilization of existing space. Along the east side of Valley Service Road, approximately 60 acres opposite and south of the project area between the North Haven Mall and Route 5/22 are potentially available for secondary commercial and office development. It should be noted that office space is projected to occur in either one office building or as second story office space above the retail establishments. Since much of the area along Washington Avenue is already developed, additional impacts to surface water resources and water quality would be primarily derived from the area along the east side of Valley Service Road.

Similar to those developments associated with recently approved or pending building permit applications, impacts derived from secondary development along the east side of Valley Service Road would likely include the alteration of onsite drainage patterns, increases in the concentrations of various parameters, above background water quality in the Quinnipiac River, and the loss of aquatic organisms. However, the degree to which these impacts occur will be dependent on the extent to which each site is developed, stormwater management practices, and the application of mitigative measures.

Residential development generated as a result of the proposed project would be negligible. This is due to the likelihood of existing residential areas in the Town of North Haven supporting the estimated number of persons seeking residence in the Town as a result of the proposed project (See Appendix L - Economic and Land Use Impacts of the North Haven Mall). Thus, negligible if any, cumulative impacts to surface water resources and water quality are expected to result from secondary residential development.

3.6 Summary

Water quality data pertaining to conditions in the Quinnipiac River have been reviewed. Data obtained from the USGS and Connecticut DEP indicated considerable existing loading of the Quinnipiac River with nitrogenous compounds, phosphorus, BOD, bacteria, and solids. Severe decreases in dissolved oxygen concentrations have been found in many reaches of the River and violated the Class C water quality criteria. The major contributors to water quality problems in the River have been reported to be municipal sewage treatment facilities.

A site specific water quality analysis program was conducted. Two sampling locations were established on the Quinnipiac River and one station was located near the westerly terminus of the DOT drainage channel which transects the proposed mall site. An additional sampling station was located between the two large ponds and another at the twin 84 in. culverts east of Valley Service

Road. The data obtained in this study on general water quality in the Quinnipiac River were found to be consistent with data collected at other sampling locations by the USGS. Excessive nitrogen and phosphorus concentrations, for example, were found in both studies. Samples were also collected during a storm event and the analyses indicated large fluctuations in a number of water quality parameters. Perhaps one of the most striking was a ten fold increase over normal flow conditions in sodium concentrations in the Quinnipiac River. The wet weather water quality data were used as the basis for later computations of solute balances.

An evaluation of potential impacts to water quality was conducted by computation of solute balances for a number of trace metals, nitrogen, phosphorus, and bacteria. The resulting concentrations suggested an alteration of water quality in the water entering the detention pond with subsequent dilution in the Quinnipiac River. Although the operation of the proposed mall would add to the existing base conditions of the Quinnipiac River, the overall concentrations of metals and nutrients would not be significantly changed so as to affect the classification of the River or to affect aquatic flora and fauna.

4.0 UNAVOIDABLE ADVERSE IMPACTS

Impacts to water quality and aquatic organisms which cannot be avoided either during constructon or operation of the proposed project include:

- Periodic increased amounts of suspended solids during storm events in the onsite ponds from construction. (This is due to the ponds being used to mitigate impacts to the Quinnipiac River).
- Periodic increased amounts of suspended solids during storm events in the proposed detention pond from operation of the facility.
- Increased loads of organic and inorganic materials in the onsite detention pond and, to a lesser extent, in the Quinnipiac River as a result of traffic on the parking areas and access roadways.
- Loss of aquatic life in onsite surface waters as a result of filling of open water areas and the DOT drainage channel.
- Loss of anadromous fish habitat associated with onsite ponds being filled.

The magnitude of the first four areas of impact have been described in previous sections and the computations indicate slight modifications of receiving water quality in the detention pond and little to no impact to the Quinnipiac River. The greatest impacts will be the loss of open water habitat which include the same areas where spawning of warm water fish and anadromous fish presently occur. Provision of fish access to the detention pond has been detailed and is presented in Appendix E - Stormwater Management. As subsequently stated in Section 6.0, the proposed outlet structure between the detention pond and the Quinnipiac River would allow for the passage of fish and would serve to mitigate such biological impacts as the loss of habitat for anadromous fish.

5.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Commitments of this nature resulting from the construction and operation of the North Haven Mall include the loss of six acres of existing open water habitat and the attendant displacement of fish, to some extent mortality, and the loss of spawing areas for anadromous species. Additional commitments include the conversion of lands previously altered by mining operations to open water, a measure which will serve to mitigate the proposed project's impacts on fish. Operation of the facility would also result in a limited increased load of contaminants to the Quinnipiac River.

6.0 METHODS TO MINIMIZE IMPACTS

A phased excavation and filling process of the open water areas, as discussed in Appendix D - Sediment and Erosion Control, would mitigate short term impacts which would be associated with construction of the facility. The implementation of the proposed Sediment and Erosion Control plan and the detention pond would also minimize water quality and aquatic biological impacts.

For mitigation of water quality impacts during operation of the facility, the pavement should be swept two times each month to reduce the amount of accumulated dust and dirt. The possibility of limiting the application of deicing compounds may also be an available option to reduce opportunities for water quality impacts.

The construction of an outlet structure which would allow continued migration of anadromous fish into the detention pond for spawning would also serve to mitigate biological impacts. Appendix E - Stormwater Management presents the outlet structure which best suits the primary requirement of detention and the additional role of fish passage. Also, inlets to the onsite stormwater collection system would be fitted with devices to minimize the opportunity for floatables, i.e. oil and grease, to enter the detention pond or the River.

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ATTACHMENT A

STATE OF CONNECTICUT

WATER QUALITY STANDARDS

Adopted by the Commissioner

Department of Environmental Protection

September 9, 1980

INLAND WATERS

CLASS B_c

Suitable for bathing, other recreational purposes, agricultural uses, certain industrial processes and cooling; excellent fish and wildlife habitat, good aesthetic value.

1.	Dissolved Oxygen	Not less than 5 mg/l at any time.
2.	Sludge deposits-solid refuse-floating solids, oils and grease-scum	None except for small amounts that may result from the discharge from a waste treatment facility providing appropriate treatment.
3.	Silt or sand depoits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity or at dredge material disposal provided all reasonable controls are used.
4.	Color and Turbidity	Turbidity shall not exceed 25 JTU, Bc 10 JTU over ambient levels. A Secchi disk shall be visible at a minimum depth of 1 meter, Class B_b-criteria may be exceeded (See Note 6).
5.	Coliform bacteria per 100 ml	Fecal coliform shall not exceed a log mean of 200 organisms/100 ml nor shall 10 percent of the samples exceed 400 organisms/100 ml.
6.	Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class nor cause taste and odor in edible fish.
7.	pH	6.5 - 8.0
8.	Allowable temperature increase	None except where the increase will not exceed the recommended limit on most sensitive receiving water use and in no case exceed 85°F, or in any case raise the normal temperature of the receiving water more than 4°F.
9.	Chemical constituents	See General Policy 11.

INLAND WATERS

CLASS C

Suitable for certain fish and wildlife habitat, recreational boating, and certain industrial processes and cooling; good aesthetic value.

1.	Dissolved Oxygen	Not less than 4 mg/l at any time.
2.	Sludge deposits-solid refuse-floating solids, oils and grease-scum	None except for small amounts that may result from the discharge from a waste treatment facility providing appropriate treatment.
3.	Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, or dredge material disposal provided all reasonable controls are used.
4.	Color and turbidity	Turbidity shall not exceed 25 JTU.
5.	Coliform bacteria per 100 ml	Fecal coliform shall not exceed a log mean of 1,000 organisms/100 ml nor shall 10 percent of the samples exceed 2,500 organisms/100 ml.
6.	Taste and Odor	None in such concentrations that would impair any usages specifically assigned to this class nor cause taste and odor in edible fish.
7.	pH	6.0 - 8.5
8.	Allowable temperature increase	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 85^{o}F or in any case raise the normal temperature of the receiving water more than 4^{o}F.
9.	Chemical constituents	See General Policy 11.

COASTAL AND MARINE WATERS

CLASS SB

Suitable for bathing, other recreational purposes, industrial cooling and shellfish harvesting for human consumption after depuration; excellent fish and wildlife habitat; good aesthetic value.

1.	Dissolved oxygen	Not less than 5.0 mg/l at any time.
2.	Sludge deposits-solid refuse-floating solids, oils and grease-scum	None except for small amounts that may result from the discharge from a waste treatment facility providing appropriate treatment.
3.	Sand or silt deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity or dredge material disposal provided all reasonable controls are used.
4.	Color and turbidity	A Secchi disc shall be visible at a minimum of 1 meter, Class SB_b criteria may be exceeded (See Note 6).
5.	Coliform bacteria per 100 ml	Fecal coliform shall not exceed a log mean of 200 organisms/100 ml nor shall 10 percent of the samples exceed 400 organisms/100 ml.
6.	Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.
7.	pH	6.8-8.5
8.	Allowable temperature increase	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83 degrees F or in any case raise the normal temperature of the receiving water more than 4 degrees F. During the period including July, August, and September, the normal temperature of the receiving water shall not be raised more than 1.5 degrees F unless it can be shown that spawning and growth of indigenous organisms will not be significantly affected.

9.	Chemical constituents	None in concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, or impair the water for any other usage assigned to the class (See General Policy 11).

COASTAL AND MARINE WATERS

CLASS SC

Suitable for fish, shellfish, and wildlife habitat; suitable for recreational boating and industrial cooling; good aesthetic value.

1. Dissolved Oxygen	Not less than 4 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids, oils and grease-scum	None except for small amounts that may result from the discharge from a waste treatment facility providing appropriate treatment.
3. Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, or dredge material disposal provided all reasonable controls are used.
4. Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
5. Coliform bacteria per 100 ml	Fecal coliform shall not exceed a log mean of 1,000 organisms/100 ml nor shall 10 percent of the samples exceed 2,500 organisms/100 ml.
6. Taste and Odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.
7. pH	6.5 - 8.5
8. Allowable temperature increase	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83^{o}F or in any case raise the normal temperature of the receiving water more than 4^{o}F. During the period including July, August, and September, the normal temperature of the receiving water shall not be raised more than 1.5^{o}F unless it can be shown that spawning and growth of indigenous organisms will not be significantly affected.

9.	Chemical constituents	None in concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, or impair the water for any other usage assigned to this class (See General Policy 11).

COASTAL AND MARINE WATERS

CLASS SD

May be suitable for bathing or other recreational purposes, fish and wildlife habitat and industrial cooling; may have good aesthetic value. Present conditions, however, severely inhibit or preclude one or more of the above uses.

WATER QUALITY STANDARDS

GENERAL POLICIES

1. It is the policy of the State to restore or maintain the surface waters of the State to a quality consistent with their use for the protection and propagation of fish, shellfish, and wildlife including breeding, feeding and nursery grounds, and with their use for recreation. In keeping with this policy, all surface waters will be restored to the extent possible at least to a quality consistent with Class B or Class SB. Such classifications are proposed throughout the State in these standards. However, where they will not be achieved within three years, the anticipated condition on December 31, 1982 is also identified. These anticipated conditions on December 31, 1982 are the best present estimate of the results which can be expected to be achieved from the water pollution control program over a three year period.

2. Surface waters with existing quality better than established standards will be maintained at their existing high quality. Surface waters of the State will not be lowered in class designation unless and until it has been affirmatively demonstrated to the Commissioner that such change is justifiable as a result of necessary economic or social development and unless it will not interfere with or become injurious to any assigned uses made of, or presently possible in, such waters. Any applicant for a new discharge to high quality waters will be required to justify the project as described above as part of the initial project design and provide a minimum level of treatment equal to or exceeding the applicable standards of performance for new sources promulgated pursuant to the Federal Water Pollution Control Act.

3. It is the policy of the State to restore or maintain the quality of the groundwater to a quality consistent with its use for drinking without treatment. In keeping with this policy, all groundwaters shall be restored to the extent possible to a quality consistent with Class GA. However, restoration of groundwater to Class GA shall not be sought when:

   A) The groundwater is in a zone of influence of a permitted discharge.
   B) The groundwater is designated as Class GB; unless there is a demonstrated need to restore groundwaters to a Class GA designation or where it can be demonstrated to the Commissioner that restoration to Class GA can be reasonably achieved.
   C) The groundwater is designated Class GC.

4. The zone of influence of a discharge may be described as the soil or water area needed to allow the treatment of effluent by soils or the mixing of effluent with ground or surface waters. The establishment of zones of influence created by a permitted discharge shall not affect the adopted water usage class. The zone of influence is used by the Commissioner in permitting and regulating discharges to the waters of the State. The Commissioner is required to determine whether any proposed system to treat a discharge will protect the waters of the State from pollution.

A) Surface Waters

(1) Wherever zones of influence are allowed, zones of passage for free swimming and drifting aquatic organisms shall be provided.
(2) No minimum criteria can be given for zones of passage because of varying hydraulic, physical/chemical, and biological considerations.
(3) As a guideline, zones of influence should be limited to no more than 25 percent of the cross-sectional area or volume of flow, leaving at least 75 percent free for a zone of passage.
(4) The cross-sectional area or volume of flow assigned to zones of influence shall be limited to that which will not adversely affect biological value to a degree which is damaging to the ecosystem.

B) Groundwaters

(1) Zones of influence may be allowed and the determination of boundaries of a zone shall be required when natural soil materials are used to treat a discharge or to allow the dilution of substances by groundwater to acceptable concentrations for discharge to the surface waters in an effluent/groundwater mix which will not violate the established water quality classification for the surface water.
(2) The zone of influence for subsurface sewage disposal systems which are permitted under the authority delegated to the Commissioner of Health Services by Section 25-54i-1.0-5.2 shall be defined as the area required by the separating distances established as minimum requirements of the Public Health Code.
(3) The zone of influence for all other discharges to the groundwater shall be the area in which the groundwater could be in violation of any pertinent Federal and State drinking water standards or otherwise be polluted by the discharge.

5. It shall be the general policy of the State to limit discharges to the surface waters to the following categories:

   A) Class AA surface waters may be suitable to receive backwash discharges from public or private drinking water treatment systems subject to the approval of the Commissioner of Health Services, provided the backwash discharge is treated to a level which may be considered clean water and which in the judgment of the Commissioner equals or exceeds the quality of raw water from which it is drawn.

   B) Class A and SA surface waters may be suitable to receive discharge from treated backwash waters from public or private drinking water treatment systems, minor cooling and clean water discharges, and dredging and dredged material dewatering operations.

   C) Class B and SB surface waters may be suitable to receive cooling water discharges and major and minor discharges from municipal and industrial wastewater treatment systems. In addition, certain in-river sand and gravel mining operations may be permissible.

   D) The designation of surface waters as Class C or Class SC shall not be a reason for authorizing a new discharge that would not allow the receiving surface waters to attain Class B or Class SB.

6. It shall be the policy of the State to limit discharges to the groundwaters to the following categories:

   A) Class GAA areas may be suitable to receive discharges of domestic sewage as defined in Section 25-54i-1.0 or wastes from acceptable agricultural practices or backwash from public drinking water treatment systems or other minor cooling or clean water discharges.

   B) Class GA areas may be suitable to receive those discharges permitted in Class GAA areas and septage or other wastes of predominantly human or animal origin. These groundwaters may also receive effluents containing substances of natural origin or materials which easily biodegrade in the soil system and pose no threat to untreated drinking water supplies drawn from the groundwater outside any zone of influence.

   C) Class GB areas may be suitable for receiving discharges permitted in Class GAA and Class GA. In addition, these groundwaters may be suitable for receiving certain treated industrial process waters amenable to further treatment by the soils. Such discharges shall not cause degradation of groundwaters that could preclude future use of the groundwater for drinking supplies without treatment or violate adjacent surface water classification.

Class GB groundwaters are those located in areas where historical, industrial, commercial, or residential development has or is likely to render the groundwaters unsuitable for drinking water without treatment. However, the intent is to prevent new discharges from causing further degradation.

D) Class GC areas may be suitable for all discharges allowed in areas designated as Class GAA, Class GA, and Class GB. Class GC areas may also be suitable for other discharges operating under a Section 25-54i discharge permit, as long as such discharges will not cause a violation of an adjacent surface water classification. The groundwaters in Class GC areas may be unsuitable for drinking water purposes without treatment. There is a present and continuing need to allow discharges to the ground which are currently best treated by making use of the restoration or attenuation characteristics of the soil and subsurface hydrogeologic conditions. The best places to meet this need in Connecticut exist in limited areas of the State where specific soil and hydrogeologic conditions exist that may be most favorable to the acceptance of such discharges and the existing land uses are compatible with such discharges. In many Class GC areas, the historic waste disposal practices may have, for all practical purposes, permanently rendered the groundwater unsuitable for drinking water without treatment, and/or development of large yield and high quality water supply from the aquifer conditions is unlikely.

7. Groundwaters assigned to a specific class are not protected by such designation when the subsequent withdrawal of groundwaters creates a gradient from adjacent water or from an authorized zone of influence or from adjacent groundwater areas of different classification.

8. It shall be the general policy of the State to require all sewage treatment plants to disinfect their effluent prior to its discharge to the surface waters with the exception of discharges to the following streams for which disinfection shall be required only during the period from May 1st to October 1st of any year: Housatonic River north of the I-95 bridge; Naugatuck River; Quinnipiac River north of the I-95 bridge; Farmington River; Pequabuck River; Connecticut River north of the I-95 bridge; Hockanum River; Willimantic River; Shetucket River; Quinebaug River; and the Thames River north of the I-95 bridge. It is recognized that criteria for coliform bacteria may not be met on the above streams during the period when disinfection of sewage treatment plant effluent is not required. The degree of treatment and disinfection shall be as required by the Commissioner and shall be consistent with the health standards established by the Commissioner of Health Services.

9. Coastal and marine waters are those generally subject to the rise and fall of the tide and as defined by Section 22a-93 of the Connecticut General Statutes as amended by P.A. 79-535 Section 3(5).

10. Consideration of other criteria will constitute a portion of the continuing effort of the Commissioner to further define water quality standards. The Commissioner reserves the right to amend or extend the criteria for each class of waters as new information or improved or more stringent criteria relative to water quality impacts are developed and justified subject to the legal and procedural requirements of State and Federal laws or regulations.

11. The waters shall be free from chemical constituents in concentrations or combinations which would be harmful to human, animal, or aquatic life for the most sensitive and governing water use class. Criteria for chemical constituents contained in guidelines published by the U.S. Environmental Protection Agency shall be considered. In areas where fisheries are the governing consideration and numerical limits have not been established, bioassays may be necessary to establish limits on toxic substances. The recommendations for bioassay procedures contained in "Standard Methods for the Examination of Water and Wastewater" and the application factors contained in EPA water quality guidelines shall be considered.

    A) For surface waters classified for use as public drinking water, the raw water sources must be maintained at a quality as defined by criteria developed by the U.S. EPA in accordance with the Safe Drinking Water Act (P.A. 93-523) or the State of Connecticut (Section 19-13-B102 of the Regulations of Connecticut State Agencies), whichever is more stringent, so that criteria for finished water can be met after conventional treatment.

    B) For groundwaters classified for use as public or private drinking water (Classes GAA and GA), the raw water sources must be maintained or restored at a quality as defined by criteria developed by the U.S. EPA or the State, whichever is more stringent, so that criteria for finished water can be met without treatment.

12. The discharge of radioactive materials in concentrations or combinations which would be harmful to human, animal, or aquatic life shall not be allowed. In no case shall the Alpha emitters in a surface water exceed a concentration of 1,000 picocuries per liter.

13. Reasonable controls may be defined by the Commissioner on a case-by-case basis or the Commissioner may require that it be affirmatively demonstrated by any person or municipality engaged in such activities that all reasonable controls will be or are being used.

14. The minimum average daily flow for seven consecutive days that can be expected to occur once in ten years under natural conditions is the minimum flow to which the standard for surface waters apply, except when a stream has been historically regulated to result in low flows below that level, in which case the standards apply to the absolute low flow resulting from such regulation.

15. Except within designated dredged material disposal areas, waters shall be substantially free of pollutants that: (a) unduly affect the composition of bottom fauna; (b) unduly affect the physical or chemical nature of the bottom; or (c) interfere with the propagation and habitats of shellfish, finfish, and wildlife. Dredged materials dumped at approved disposal areas shall not pollute the waters of the State and shall not result in: (a) floating residues of any sort; (b) release of any substance, biological or chemical constituents which may result in long-term or permanent degradation of water quality in waters overlying or adjacent to the dumping grounds; (c) dispersal of sediments outside a zone of influence enclosing the designated dump points; or (d) biological mobilization and subsequent transport of toxic substances to food chains.

16. Proposed drinking water supply intakes and impoundments and tributary surface waters identified in the Long Range Plan for Management of Water Resources prepared and adopted pursuant to Section 25-5b of the Connecticut Statutes shall be adopted as Class AA.

17. Section 25-26(a) of the Connecticut General Statutes imposes an absolute restriction on the discharge of sewage to Class AA surface waters. The coliform bacteria criteria of "none of human origin" if violated by a discharge source outside the state where similar requirements are not imposed, shall not be a valid rason for either relaxing such restriction in Connecticut or changing the Class AA water quality standard. It shall be the policy of Connecticut to pursue the adoption of compatible Water Quality Standards in neighboring states to assure the protection of drinking water supplies in Connecticut.

18. Physical obstruction such as dams, which prevent cold water fish from reaching an area suitable for spawning and growth, shall not be considered a vaild reason for not meeting the criteria.

19. There shall be no point source discharge into any natural lake or pond or tributary surface waters which will raise the phosphorus concentration of the receiving surface waters, including phosphorus contained in suspended matter, to an amount in excees of 0.03 mg/l. For the purpose of this policy the Class B or Class C impoundments listed below shall be considered natural lakes or ponds.

Town	Lake or Pond
Bozrah	Fitchville Pond
Griswold	Ashland Pond
Killingly	Fivemile Pond
Stafford	Glenville Pond
Stafford	Riverside Pond
Stafford	Warren Pond

20. Upstream of the mouths of the Housatonic River, Connecticut River, and Thames River, the allowable temperature increase shall be consistent with the corresponding non-tidal surface water.

NOTES

These notes include additional criteria and supplementary information to insure proper interpretation and use of the criteria.

1. These criteria do not apply to conditions brought about by natural causes. Conditions which exist in the water in part due to man's normal uses of the land shall be considered natural. In the case of Class AA watersheds, man's normal use of the land means farming and other agricultural practices, low density residential development and the improvement and maintenance of secondary roads provided Best Management Practices are used. Thus the meaning of the word natural is not limited to only those conditions which would exist in the water if drained from pristine land.

2. Water courses which are contained in drainage conduits or pipes and which are not assigned a specific class are considered to be the class of the stream segment to which they discharge.

3. Class D and Class SD waters are considered unacceptable.

4. Existing and proposed drinking water supply sources and lands from which they drain may be subject to restricted use by State regulations, local ordinance, or by the property owner.

5. A) In order to assure a reasonable level of confidence, criteria for coliform bacteria and fecal coliform are to be based on a minimum of five samples taken over a 30 day period.

   B) In addition to criteria for coliform bacteria, another criteria useful in judging the sanitary quality of water is the Fecal Coliform/Fecal Streptococci ratio. Fecal Streptococci are native to the intestines of warm blooded animals including man and like coliform are considered non-pathogenic. What makes the FC/FS ratio useful is the fact that the research has shown the ratio for human wastes to be about 4.4 and the ratio for common domestic animals to be considerably less than 1.0. The rates of die-off for coliform and streptococci organisms is different and therefore the ratio is most meaningful when the contamination is less than 24 hours old.

   The following ratios can be used as a useful tool in interpreting data for which both Fecal Coliform and Fecal Streptococci values exist:

FC/FS Ratio	Significance
Greater than 4.0	Strong evidence that pollution is from human wastes
Between 2.0 and 4.0	May suggest a predominance of human waste in mixed pollution.
Between 1.0 and 2.0	Uncertain interpretation.
Between 0.7 and 1.0	May suggest a predominance of livestock and poultry wastes in mixed pollution.
Less than 0.7	Strong evidence that pollution is from livestock and poultry waste and not human wastes.

6. The use of subscript b in Classes A_b, B_b, and SB_b is intended to identify those areas where natural conditions or conditions which cannot be expected to be appreciably altered by the control of discharges may preclude bathing. It may also be used in Classes B_b and SB_b to designate areas in the immediate vicinity of treated sewage outfalls where bathing is not advisable.

7. The use of subscript c in Classes B_c, C_c, SB_c is to identify areas suitable for cold water fisheries including spawning, growth and passage.

8. Sample collection, preservation, handling, and analysis should conform to "Standard Methods for the Examination of Water and Wastewaters," 14th Edition, American Public Health Association, New York, NY. The following references may be used where they contain applicable laboratory methods.

   A) "ASTM Standards", Part 23, Water; Atmospheric Analysis, 1970; American Society of Testing and Materials, Philadelphia, Pennsylvania 19103.

   B) "Methods of Chemical Analysis of Water and Wastes", Environmental Protection Agency Water Quality Office, Analytical Quality Control Laboratory, 1014 Broadway, Cincinnati, Ohio 45263.

   C) Any later edition of the above references or any other different but equivalent methods approvded by the Commissioner.

9. Property rights to groundwater and the ability to degrade groundwater are not granted by the assignment of groundwater to a class. The Commissioner may require applicants for Section 25-54i permits to demonstrate that they have acquired the rights to any groundwater which may be degraded by a discharge or its zone of influence. The Commissioner may also require any applicant for such discharge to record on the land records of the relevant town(s) the effect and extent of any discharge on the groundwaters and the effect and duration of effect of any discharge following cessation of the discharge.

ATTACHMENT B

QUINNIPIAC RIVER BASIN

01196500 QUINNIPIAC RIVER AT WALLINGFORD, CT--Continued

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1953-54, 1957, 1968 to current year.

PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: November 1969 to December 1970.
WATER TEMPERATURES: November 1969 to December 1970.

REMARKS.--Records of iron, specific conductance, and pH of daily samples for 1956-57 are available in district office at Hartford, Conn.

EXTREMES FOR PERIOD OF RECORD.--
SPECIFIC CONDUCTANCE: Maximum recorded, 530 micromhos July 16, 1970; minimum recorded, 47 micromhos July 4, 1970.
WATER TEMPERATURES: Maximum, 31.0°C July 28, 1970; minimum, 0.0°C on many days during winter periods.

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TIME	STREAMFLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE, AIR (DEG C)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (NTU)	OXYGEN, DISSOLVED (MG/L)	OXYGEN, DISSOLVED (PERCENT SATURATION)	COLIFORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)
OCT												
18...	1345	91	360	7.4	14.0	11.0	20	4.0	9.3	86	14000	3800
NOV												
09...	1320	86	405	7.2	15.0	11.0	35	6.0	10.1	91	32000	4500
DEC												
15...	1330	185	365	7.2	5.0	2.5	20	7.0	13.0	95	68000	18000
JAN												
12...	1400	372	265	6.9	-4.0	1.0	10	5.0	14.4	100	26000	16000
FEB												
06...	1040	249	310	6.8	<-5.0	.5	10	9.0	13.9	96	47000	28000
MAR												
12...	1340	930	185	7.2	2.5	3.5	20	6.0	13.6	103	34000	17000
APR												
10...	1030	440	255	6.5	6.0	6.0	10	2.0	12.1	97	68000	9000
MAY												
11...	1350	312	270	6.9	24.0	22.0	10	7.0	8.6	98	2300	170
JUN												
14...	1430	220	292	6.8	25.0	20.5	5	5.0	7.7	85	3600	420
JUL												
17...	1400	75	300	6.9	31.0	27.0	5	8.0	6.3	77	2200	210
AUG												
07...	1425	88	246	6.9	27.5	25.0	20	9.0	7.0	83	4300	1000
SEP												
18...	1320	78	340	7.5	25.5	20.0	10	5.0	6.6	72	2300	960

DATE	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	ALKALINITY (MG/L AS CACO3)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)
OCT												
18...	45	--	--	--	--	--	--	--	30	--	204	.28
NOV												
04...	56	--	--	--	--	--	--	--	32	--	219	.30
DEC												
15...	3300	92	30	28	5.4	62	--	26	33	12	181	.25
JAN												
12...	2300	--	--	--	--	--	--	--	24	--	139	.19
FEB												
06...	3600	--	--	--	--	--	--	--	26	--	174	.24
MAR												
12...	9600	49	20	15	2.8	29	--	16	17	8.2	97	.13
APR												
10...	1800	--	--	--	--	--	--	--	23	--	142	.19
MAY												
11...	K13	90	32	28	4.8	58	--	22	22	8.8	163	.22
JUN												
14...	92	--	--	--	--	--	--	--	26	--	180	.24
JUL												
17...	24	--	--	--	--	--	--	--	28	--	215	.29
AUG												
07...	150	75	23	23	4.2	52	13	23	23	9.6	159	.22
SEP												
18...	110	--	--	--	--	--	--	--	30	--	215	.29

< ACTUAL VALUE IS KNOWN TO BE LESS THAN THE VALUE SHOWN
K RESULTS BASED ON COLONY COUNT OUTSIDE THE ACCEPTABLE RANGE
(NON-IDEAL COLONY COUNT)

01196500 QUINNIPIAC RIVER AT WALLINGFORD, CT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	SOLIDS, DIS-SOLVED (TONS PER DAY)	SOLIDS, RESIDUE AT 105 DEG. C, TOTAL (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS NH4)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS NO3)
OCT 18...	50.1	216	--	--	2.2	1.6	--	.70	2.3	4.5	20
NOV 09...	49.7	235	--	--	2.1	2.1	--	.90	3.0	5.1	23
DEC 15...	90.4	186	--	--	1.6	1.6	--	.70	2.3	3.9	17
JAN 12...	140	148	--	--	1.3	.61	--	.49	1.1	2.4	11
FEB 06...	117	202	--	--	1.5	1.4	--	.80	2.2	3.7	16
MAR 12...	244	149	--	--	.92	.35	--	.65	1.0	1.9	8.5
APR 10...	169	168	--	--	1.2	.65	--	3.3	3.9	5.1	23
MAY 11...	137	182	--	--	1.3	.53	.64	.57	1.1	2.4	11
JUN 14...	107	227	--	--	2.1	.65	.79	.65	1.3	3.4	15
JUL 17...	43.9	125	--	--	1.3	1.8	2.2	1.1	2.9	4.2	19
AUG 07...	37.6	201	--	--	1.5	.81	.93	1.2	2.0	3.5	16
SEP 18...	45.3	240	2.3	.20	2.5	1.8	2.2	.50	2.3	4.8	21

DATE	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS TOTAL (MG/L AS PO4)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	ZINC, DIS-SOLVED (UG/L AS ZN)	CARBON, ORGANIC TOTAL (MG/L AS C)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)	CHLOR-A PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)	CHLOR-B PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)
OCT 18...	1.1	--	17	--	--	20	6.8	.30	--	--
NOV 09...	.97	--	10	--	--	20	7.2	--	--	--
DEC 15...	.61	--	23	220	190	30	5.1	.20	.000	.000
JAN 12...	.34	--	14	--	--	30	3.6	--	--	--
FEB 06...	.41	--	9	--	--	20	5.0	--	--	--
MAR 12...	.20	--	5	150	90	20	5.5	.10	.530	.000
APR 10...	.33	--	11	--	--	30	6.6	--	--	--
MAY 11...	.44	1.4	11	70	160	20	14	.10	12.5	.000
JUN 14...	.61	1.9	13	--	--	20	6.2	--	--	--
JUL 17...	.96	2.9	8	--	--	10	7.5	--	--	--
AUG 07...	.76	2.3	14	170	310	20	12	.20	36.6	6.66
SEP 18...	.99	3.0	16	--	--	10	8.5	--	--	--

QUINNIPIAC RIVER BASIN

01196530 QUINNIPIAC RIVER AT NORTH HAVEN, CT

LOCATION.--Lat 41°23'24", long 72°52'19", New Haven County, Hydrologic Unit 01100004, at bridge on U.S. Highway 5, at North Haven, 2.3 mi (3.7 km) downstream from Wharton Brook and 0.9 mi (1.4 km) upstream from Watermans Brook.

DRAINAGE AREA.--128 mi^2 (332 km^2).

PERIOD OF RECORD.--Water year 1974 to current year.

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	TIME	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE, AIR (DEG C)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (NTU)	OXYGEN, DISSOLVED (MG/L)	OXYGEN, DISSOLVED (PERCENT SATURATION)	COLIFORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
OCT 18...	1120	390	7.1	9.0	10.5	20	4.0	8.3	74	32000	30000	640
NOV 09...	1150	430	7.3	14.0	12.0	40	6.0	8.6	80	--	29000	2400
DEC 18...	1415	385	7.2	1.5	3.0	15	6.0	13.0	96	58000	8000	500
JAN 12...	1310	270	7.1	-5.0	1.0	10	8.0	12.8	89	30000	18000	2600
FEB 06...	0910	310	6.9	<-5.0	1.5	10	20	10.2	73	51000	48000	5200
MAR 12...	1235	175	7.2	1.0	4.0	20	9.0	11.8	90	32000	7000	3100
APR 10...	0850	270	6.5	5.0	6.0	10	4.0	9.7	78	110000	20000	2100
MAY 11...	1210	290	7.1	25.0	21.0	10	8.0	5.1	57	--	300	28
JUN 14...	1230	325	6.8	23.0	19.0	5	10	4.7	51	72000	1700	170
JUL 17...	1245	380	6.9	30.0	26.0	10	10	2.2	27	5800	390	28
AUG 07...	1315	268	6.8	27.5	23.5	17	8.0	3.8	44	18000	1200	130
SEP 18...	1215	385	7.4	24.5	19.0	12	3.0	3.5	38	20000	3100	76

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	ALKALINITY (MG/L AS CACO3)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)
OCT 18...	--	--	--	--	--	--	--	34	--	235	.32
NOV 09...	--	--	--	--	--	--	--	35	--	252	.34
DEC 18...	110	35	33	6.1	73	--	31	34	3.5	203	.28
JAN 12...	--	--	--	--	--	--	--	25	--	150	.20
FEB 06...	--	--	--	--	--	--	--	28	--	183	.25
MAR 12...	49	20	15	2.8	29	--	16	17	7.9	94	.13
APR 10...	--	--	--	--	--	--	--	23	--	154	.21
MAY 11...	93	29	29	5.0	64	--	25	25	9.4	175	.24
JUN 14...	--	--	--	--	--	--	--	31	--	214	.29
JUL 17...	--	--	--	--	--	--	--	35	--	258	.35
AUG 07...	84	26	26	4.7	58	18	26	26	9.7	175	.24
SEP 18...	--	--	--	--	--	--	--	38	--	259	.35

< ACTUAL VALUE IS KNOWN TO BE LESS THAN THE VALUE SHOWN

QUINNIPIAC RIVER BASIN

01196530 QUINNIPIAC RIVER AT NORTH HAVEN, CT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	SOLIDS, RESIDUE AT 105 DEG. C, TOTAL (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS NH4)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS NO3)
OCT 18...	251	--	--	2.5	2.1	--	2.3	4.4	6.9	31
NOV 09...	266	--	--	2.3	3.0	--	4.9	7.9	10	45
DEC 18...	207	--	--	1.9	1.7	--	2.0	3.7	5.6	25
JAN 12...	161	--	--	1.5	.73	--	1.8	2.5	4.0	18
FEB 06...	192	--	--	1.7	1.9	--	2.6	4.5	6.2	27
MAR 12...	122	--	--	.98	.61	--	.79	1.4	2.4	11
APR 10...	171	--	--	1.3	.98	--	1.6	2.6	3.9	17
MAY 11...	195	--	--	1.4	.91	1.1	2.0	2.9	4.3	19
JUN 14...	328	--	--	2.3	1.4	1.7	5.1	6.5	8.8	39
JUL 17...	308	--	--	2.8	3.9	4.7	6.1	10	13	57
AUG 07...	208	--	--	1.8	1.2	1.5	1.2	2.4	4.2	19
SEP 18...	280	4.4	.24	4.6	2.8	3.4	8.2	11	16	69

DATE	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS TOTAL (MG/L AS PO4)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	ZINC, DIS-SOLVED (UG/L AS ZN)	CARBON, ORGANIC TOTAL (MG/L AS C)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)	CHLOR-A PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)	CHLOR-B PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)
OCT 18...	1.2	--	17	--	--	50	8.1	.20	--	--
NOV 09...	1.5	--	11	--	--	30	15	--	--	--
DEC 18...	.75	--	7	110	200	50	7.8	.10	.000	.000
JAN 12...	.37	--	15	--	--	40	5.3	--	--	--
FEB 06...	.47	--	7	--	--	20	8.7	--	--	--
MAR 12...	.20	--	6	120	80	10	6.2	.10	.000	.000
APR 10...	.46	--	17	--	--	40	9.0	--	--	--
MAY 11...	.56	1.7	12	70	180	10	12	.10	19.7	.000
JUN 14...	.98	3.0	11	--	--	20	12	--	--	--
JUL 17...	1.1	3.4	13	--	--	10	15	--	--	--
AUG 07...	.81	2.5	10	90	240	20	9.9	.10	28.9	.000
SEP 18...	1.1	3.4	7	--	--	10	12	--	--	--

01196530 QUINNIPIAC RIVER AT NORTH HAVEN, CT--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979

DATE	SOLIDS, RESIDUE AT 105 DEG. C, TOTAL (MG/L)	NITRO-GEN, NITRATE TOTAL (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS NH4)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS NO3)
OCT 18...	251	--	--	2.5	2.1	--	2.3	4.4	6.9	31
NOV 09...	266	--	--	2.3	3.0	--	4.9	7.9	10	45
DEC 18...	207	--	--	1.9	1.7	--	2.0	3.7	5.6	25
JAN 12...	161	--	--	1.5	.73	--	1.8	2.5	4.0	18
FEB 06...	192	--	--	1.7	1.9	--	2.6	4.5	6.2	27
MAR 12...	122	--	--	.98	.61	--	.79	1.4	2.4	11
APR 10...	171	--	--	1.3	.98	--	1.6	2.6	3.9	17
MAY 11...	195	--	--	1.4	.91	1.1	2.0	2.9	4.3	19
JUN 14...	328	--	--	2.3	1.4	1.7	5.1	6.5	6.8	39
JUL 17...	308	--	--	2.8	3.9	4.7	6.1	10	13	57
AUG 07...	208	--	--	1.8	1.2	1.5	1.2	2.4	4.2	19
SEP 18...	280	4.4	.24	4.6	2.8	3.4	8.2	11	16	69

DATE	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS TOTAL (MG/L AS PO4)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	ZINC, DIS-SOLVED (UG/L AS ZN)	CARBON, ORGANIC TOTAL (MG/L AS C)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)	CHLOR-A PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)	CHLOR-B PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)
OCT 18...	1.2	--	17	--	--	50	8.1	.20	--	--
NOV 09...	1.5	--	11	--	--	30	15	--	--	--
DEC 18...	.75	--	7	110	200	50	7.8	.10	.000	.000
JAN 12...	.37	--	15	--	--	40	5.3	--	--	--
FEB 06...	.47	--	7	--	--	20	8.7	--	--	--
MAR 12...	.20	--	6	120	80	10	6.2	.10	.000	.000
APR 10...	.46	--	17	--	--	40	9.0	--	--	--
MAY 11...	.56	1.7	12	70	180	10	12	.10	19.7	.000
JUN 14...	.98	3.0	11	--	--	20	12	--	--	--
JUL 17...	1.1	3.4	13	--	--	10	15	--	--	--
AUG 07...	.81	2.5	10	90	240	20	9.9	.10	28.9	.000
SEP 18...	1.1	3.4	7	--	--	10	12	--	--	--

ATTACHMENT C

ORGANISM	L/N	P	TOTAL #	NO./M2	RELATIVE ABUNDANCE
DIPTERA					
Tabanus		3	3	60	23.1
TOTAL				60	23.1
TRICHOPTERA					
TOTAL					
PLECOPTERA					
TOTAL					
EPHEMEROPTERA					
TOTAL					
ODONATA					
TOTAL					
NEUROPTERA					
TOTAL					
HEMIPTERA					
TOTAL					
COLEOPTERA					
Phanocerus	1		1	20	7.7
TOTAL				20	7.7

Total Freshwater Macroinvertebrates; Parts A and B

Total # of organisms 13

Total # of genera 4

Total dry weight --

Shannon Diversity index 1.7

Freshwater Macroinvertebrate Analysis

Part A

2212-01

STATION NUMBER: B-2

COLLECTION LOCATION: North Haven

COLLECTED BY: T. Carlson

DATE COLLECTED: 4/3/80

METHOD OF COLLECTION: Ponar Dredge

NUMBER OF GRABS: 1

SAMPLE AREA: 0.05 m^2

IDENTIFIED BY: C. Noyes

L = larvae
N = nymph
P = pupae
N.Q. = not quantitative

ORGANISM	TOTAL #	NO./M 2	RELATIVE ABUNDANCE %
CRUSTACEA			
TOTAL			
HIRUDINEA			
TOTAL			
NEMATODA			
Species A	2	40	15.4
TOTAL		40	15.4
BIVALVIA			
TOTAL			
GASTROPODA			
TOTAL			
OTHER			
Oligochaeta *Limnodrilus*	7	140	53.8
TOTAL		140	53.8

Freshwater Macroinvertebrate Analysis

Part B

REMARKS:

ORGANISM	L/N	P	TOTAL #	NO./M2	RELATIVE ABUNDANCE
DIPTERA					
Tabanus	2		2	7	4.2
TOTAL				7	4.2
TRICHOPTERA					
Hydropsyche similans	1		1	4	2.4
TOTAL				4	2.4
PLECOPTERA					
TOTAL					
EPHEMEROPTERA					
TOTAL					
ODONATA					
TOTAL					
NEUROPTERA					
TOTAL					
HEMIPTERA					
TOTAL					
COLEOPTERA					
TOTAL					

Total Freshwater Macroinvertebrates; Parts A and B

Total # of organisms 168

Total # of genera 3

Total dry weight --

Shannon Diversity index 0.15

Freshwater Macroinvertebrate Analysis

Part A

2210-01

STATION NUMBER: B-3

COLLECTION LOCATION: North Haven

COLLECTED BY: T. Carlson

DATE COLLECTED: 4/3/80

METHOD OF COLLECTION: Surber

NUMBER OF GRABS: 3

SAMPLE AREA: 0.28 m^2

IDENTIFIED BY: C. Noyes

L = larvae
N = nymph
P = pupae
N.Q. = not quantitative

Freshwater Macroinvertebrate Analysis

Part B

ORGANISM	TOTAL #	NO./M 2	RELATIVE ABUNDANCE %
CRUSTACEA			
Gammarus fasciatus	165	589	98.2
TOTAL		589	98.2
HIRUDINEA			
TOTAL			
NEMATODA			
TOTAL		-	
BIVALVIA			
TOTAL			
GASTROPODA			
TOTAL			
OTHER			
TOTAL			

REMARKS:

Freshwater Macroinvertebrate Analysis

Part A

2209-01

ORGANISM	L/N	P	TOTAL #	NO./M²	RELATIVE ABUNDANCE
DIPTERA					
Tipula		1	1	5	20.0
Species A	2		2	11	40.0
TOTAL				16	60.0
TRICHOPTERA					
TOTAL					
PLECOPTERA					
TOTAL					
EPHEMEROPTERA					
TOTAL					
ODONATA					
TOTAL					
NEUROPTERA					
TOTAL					
HEMIPTERA					
TOTAL					
COLEOPTERA					
TOTAL					

Total Freshwater Macroinvertebrates; Parts A and B

Total # of organisms 5

Total # of genera 3

Total dry weight --

Shannon Diversity index 1.5

STATION NUMBER: B-3A

COLLECTION LOCATION: North Haven

COLLECTED BY: T. Carlson

DATE COLLECTED: 4/3/80

METHOD OF COLLECTION: Surber

NUMBER OF GRABS: 2

SAMPLE AREA: 0.19 m^2

IDENTIFIED BY: C. Noyes

L = larvae
N = nymph
P = pupae
N.Q. = not quantitative

Freshwater Macroinvertebrate Analysis

Part B

ORGANISM	TOTAL #	NO./M 2	RELATIVE ABUNDANCE %
CRUSTACEA			
TOTAL			
HIRUDINEA			
TOTAL			
NEMATODA			
TOTAL		-	
BIVALVIA			
TOTAL			
GASTROPODA			
TOTAL			
OTHER			
Oligochaeta			
Limnodrilus	2	11	40
TOTAL		11	40

REMARKS:

Freshwater Macroinvertebrate Analysis

Part A

2211-01

STATION NUMBER: B-4

COLLECTION LOCATION: North Haven

COLLECTED BY: T. Carlson

DATE COLLECTED: 4/3/80

METHOD OF COLLECTION: Surber

NUMBER OF GRABS: 3

SAMPLE AREA: 0.28 m^2

IDENTIFIED BY: C. Noyes

ORGANISM	L/N	P	TOTAL #	NO./M^2	RELATIVE ABUNDANCE
DIPTERA					
Ceratopogonidae	1		1	4	5.5
		TOTAL		4	5.5
TRICHOPTERA					
Hydropsyche	2		2	7	11.1
Limnophilus	1		1	4	5.5
		TOTAL		11	16.6
PLECOPTERA					
		TOTAL			
EPHEMEROPTERA					
		TOTAL			
ODONATA					
		TOTAL			
NEUROPTERA					
		TOTAL			
HEMIPTERA					
		TOTAL			
COLEOPTERA					
Hydrochara	1		1	4	5.5
		TOTAL		4	5.5

Total Freshwater Macroinvertebrates; Parts A and B

Total # of organisms 18

Total dry weight --

Total # of genera 8

Shannon Diversity index 2.2

L = larvae
N = nymph
P = pupae
N.Q. = not quantitative

ORGANISM	TOTAL #	NO./M 2	RELATIVE ABUNDANCE %
CRUSTACEA			
TOTAL			
HIRUDINEA			
TOTAL			
NEMATODA			
TOTAL		-	
BIVALVIA			
TOTAL			
GASTROPODA			
Physa	1	4	5.5
Helisoma	1	4	5.5
TOTAL		8	11.0
OTHER			
Oligochaeta			
Tribifex	1	4	5.5
Limnodrilus	10	40	55.5
TOTAL		44	61.0

Freshwater Macroinvertebrate Analysis

Part B

REMARKS:

ATTACHMENT D

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 1

Date of Sampling	8/10/79	9/3/79	9/6/79	4/23/80	5/8/80
Analysis Number	2083	2032	2033	2215	2220
TEMP	20.000				
COLOR/APP	59.000		80.000	37.000	
COLOR/TRUE	28.000		7.000	22.000	
TURBIDITY	9.000		18.000	5.200	
ALK/PHTH	0.000		0.000	0.000	
ALK/TOTAL	84.400		42.700	74.800	
CHLORIDE	28.500		50.800	22.100	
CADMIUM	0.006		0.006	0.006	
CALCIUM	31.100		31.800	29.400	
CHROMIUM	0.020		0.060	0.010	
COPPER	0.020		0.060	0.020	
IRON	0.660		0.810	0.630	
LEAD	0.050		0.050	0.005	
MAGNESIUM	4.000		5.100	4.900	
MANGANESE	0.220		0.240	0.240	
MERCURY	0.200		0.200		
NICKEL	0.020		0.020	0.009	
POTASSIUM	2.100		2.200	1.000	
SILVER	0.010		0.010	0.010	
SODIUM	20.800		195.000	12.800	
ZINC	0.020		0.040	0.020	
AMMONIA	1.080		1.800	0.160	
NITRITE			0.005		
NITRATE	2.500		3.600	3.400	
TKN	7.600		8.800	2.900	
TOT/P	0.840		1.350	0.280	
O&G	2.000		0.700	2.000	
PHENOL	0.002		0.003	0.001	
PH	6.800		6.800	6.300	
CO2	30.000			16.000	
DO	9.000		6.000	13.000	
BOD	5.500		15.000	2.100	
COD	57.500		15.000	7.200	
SOLIDS/TOT	227.100		2048.000	208.300	
SOLIDS/SUS	17.100		14.000	12.300	
SOLIDS/DIS	210.000		2034.000	196.000	
CONDUCT	325.000		18100.000	228.000	
* FECAL/COL	150.000			3200.000	
* TOTAL/COL	1600.000		225000.000	31300.000	
* FEC/STREP	28.000		1150.000	1110.000	
TOTAL/H	101.400		110.800	85.800	
Precipitation	DRY		WET	DRY	

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 1

	Mean / Geometric Mean	Standard Deviation
TEMP	20.000	
COLOR/APP	58.666	21.501
COLOR/TRUE	19.000	10.816
TURBIDITY	10.733	6.573
ALK/PHTH	0.000	0.000
ALK/TOTAL	67.300	21.838
CHLORIDE	33.800	15.066
CADMIUM	0.006	0.000
CALCIUM	30.766	1.234
CHROMIUM	0.030	0.026
COPPER	0.033	0.023
IRON	0.700	0.096
LEAD	0.035	0.025
MAGNESIUM	4.666	0.585
MANGANESE	0.233	0.011
MERCURY	0.200	0.000
NICKEL	0.016	0.006
POTASSIUM	1.766	0.665
SILVER	0.010	0.000
SODIUM	76.200	102.961
ZINC	0.026	0.011
AMMONIA	1.013	0.822
NITRITE	0.005	
NITRATE	3.166	0.585
TKN	6.433	3.118
TOT/P	0.823	0.535
O&G	1.566	0.750
PHENOL	0.002	0.001
PH	6.633	0.288
CO2	23.000	9.899
DO	9.333	3.511
BOD	7.533	6.686
COD	26.566	27.071
SOLIDS/TOT	827.800	1056.766
SOLIDS/SUS	14.465	2.433
SOLIDS/DIS	813.333	1057.151
CONDUCT	6217.666	10290.516
* FECAL/COL	692.820	
* TOTAL/COL	22418.967	
* FEC/STREP	329.402	
TOTAL/H	99.333	12.627
PRECIPITATION		

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 2

Date of Sampling	8/10/79	9/3/79	9/6/79	4/23/80	5/8/80
Analysis Number	2083	2032	2033	2215	2220
TEMP	21.000			14.000	
COLOR/APP	55.000			42.000	
COLOR/TRUE	24.000			25.000	
TURBIDITY	8.300			4.600	
ALK/PHTH	0.000			0.000	
ALK/TOTAL	84.100			74.400	
CHLORIDE	28.400			23.100	
CADMIUM	0.006			0.006	
CALCIUM	30.500			29.000	
CHROMIUM	0.020			0.010	
COPPER	0.020			0.010	
IRON	0.480			0.620	
LEAD	0.050			0.005	
MAGNESIUM	3.900			4.800	
MANGANESE	0.200			0.240	
MERCURY	0.200				
NICKEL	0.020			0.009	
POTASSIUM	2.000			1.000	
SILVER	0.010			0.010	
SODIUM	20.100			14.900	
ZINC	0.020			0.020	
AMMONIA	1.070			0.150	
NITRATE	2.600			2.000	
TKN	7.200			2.900	
TOT/P	0.770			0.290	
O&G	3.600			2.300	
PHENOL	0.001			0.001	
PH	6.900			6.600	
CO2	26.000			16.000	
DO	6.000			11.000	
BOD	4.600			3.530	
COD	56.300			6.400	
SOLIDS/TOT	211.600			195.800	
SOLIDS/SUS	7.600			11.800	
SOLIDS/DIS	204.000			184.000	
CONDUCT	319.000			222.000	
* FECAL/COL	246.000			4000.000	
* TOTAL/COL	4100.000			26400.000	
* FEC/STREP	86.000			1150.000	
TOTAL/N	99.800			87.000	
PRECIPITATION	DRY			DRY	

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 2

	Mean / Geometric Mean	Standard Deviation
TEMP	17.500	4.949
COLOR/APP	48.500	9.192
COLOR/TRUE	24.500	0.707
TURBIDITY	6.450	2.616
ALK/PHTH	0.000	0.000
ALK/TOTAL	79.250	6.858
CHLORIDE	25.750	3.747
CADMIUM	0.006	0.000
CALCIUM	29.750	1.060
CHROMIUM	0.015	0.007
COPPER	0.015	0.007
IRON	0.550	0.098
LEAD	0.027	0.031
MAGNESIUM	4.350	0.636
MANGANESE	0.220	0.028
MERCURY	0.200	
NICKEL	0.014	0.007
POTASSIUM	1.500	0.707
SILVER	0.010	0.000
SODIUM	17.500	3.676
ZINC	0.020	0.000
AMMONIA	0.610	0.650
NITRATE	2.300	0.424
TKN	5.050	3.040
TOT/P	0.530	0.339
O&G	2.950	0.919
PHENOL	0.001	0.000
PH	6.750	0.212
CO2	21.000	7.071
DO	8.500	3.535
BOD	4.065	0.756
COD	31.350	35.284
SOLIDS/TOT	203.700	11.172
SOLIDS/SUS	9.700	2.969
SOLIDS/DIS	194.000	14.142
CONDUCT	270.500	68.589
* FECAL/COL	991.967	
* TOTAL/COL	10403.846	
* FEC/STREP	314.483	
TOTAL/H	93.400	9.050
PRECIPITATION		

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 3

Date of Sampling	8/10/79	9/3/79	9/6/79	4/23/80	5/8/80
Analysis Number	2083	2032	2033	2215	2220
TEMP		20.000	18.000		
COLOR/APP		5.000	10.000	10.000	
COLOR/TRUE		5.000	10.000	3.000	
TURBIDITY		2.000	0.600	0.800	
ALK/PHTH		0.000	0.000	0.000	
ALK/TOTAL		22.000	11.400	23.500	
CHLORIDE		82.000	77.100	49.600	
CADMIUM		0.006	0.006	0.006	
CALCIUM		19.500	18.600	21.700	
CHROMIUM		0.010	0.010	0.010	
COPPER		0.010	0.010	0.020	
IRON		0.080	0.100	0.220	
LEAD		0.050	0.050	0.005	
MAGNESIUM		3.500	3.900	4.100	
MANGANESE		0.370	0.300	0.570	
MERCURY		0.200	0.200		
NICKEL		0.020	0.020	0.005	
POTASSIUM		1.000	1.100	0.780	
SILVER		0.010	0.010	0.010	
SODIUM		31.000	29.000	23.500	
ZINC		0.020	0.020	0.030	
AMMONIA		0.110	0.090	0.060	
NITRITE		0.005	0.005		
NITRATE		1.300	1.600	3.200	
TKN		0.580	0.880	1.000	
TOT/P		0.030	0.060	0.020	
O&G		0.600	0.100	2.000	
PHENOL		0.005	0.003	0.001	
PH		6.700	6.500	6.000	
CO2				8.000	
DO		11.000	8.000	15.000	
BOD		3.800	7.200	1.900	
COD		7.100	7.200	7.500	
SOLIDS/TOT		224.000	240.000	166.500	
SOLIDS/SUS		0.400	2.000	1.500	
SOLIDS/DIS		223.600	238.000	165.000	
CONDUCT		430.000	349.000	250.000	
* FECAL/COL		3000.000		2.000	
* TOTAL/COL		12800.000	345000.000	250.000	
* FEC/STREP		5600.000	13160.000	48.000	
TOTAL/H		64.000	106.000	67.000	
FLOW				1.000	
PRECIPITATION		DRY	WET	DRY	

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 3

	Mean / Geometric Mean	Standard Deviation
TEMP	19.000	1.414
COLOR/APP	8.333	2.886
COLOR/TRUE	6.000	3.605
TURBIDITY	1.133	0.757
ALK/PHTH	0.000	0.000
ALK/TOTAL	18.966	6.595
CHLORIDE	69.566	17.464
CADMIUM	0.006	0.000
CALCIUM	19.933	1.594
CHROMIUM	0.010	0.000
COPPER	0.013	0.005
IRON	0.133	0.075
LEAD	0.035	0.025
MAGNESIUM	3.833	0.305
MANGANESE	0.413	0.140
MERCURY	0.200	0.000
NICKEL	0.015	0.008
POTASSIUM	0.960	0.163
SILVER	0.010	0.000
SODIUM	27.833	3.883
ZINC	0.023	0.005
AMMONIA	0.086	0.025
NITRITE	0.005	0.000
NITRATE	2.033	1.021
TKN	0.820	0.216
TOT/P	0.036	0.020
O&G	0.900	0.984
PHENOL	0.003	0.002
PH	6.400	0.360
CO2	8.000	
DO	11.333	3.511
BOD	4.300	2.685
COD	7.266	0.208
SOLIDS/TOT	210.166	38.653
SOLIDS/SUS	1.300	0.818
SOLIDS/DIS	208.866	38.665
CONDUCT	343.000	90.149
* FECAL/COL	77.459	
* TOTAL/COL	10335.299	
* FEC/STREP	1523.684	
TOTAL/H	79.000	23.430
FLOW	1.000	
PRECIPITATION		

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 4

Date of Sampling	8/10/79	9/3/79	9/6/79	4/23/80	5/8/80
Analysis Number	2083	2032	2033	2215	2220
COLOR/APP				86.000	
COLOR/TRUE				24.000	
TURBIDITY				6.300	
ALK/PHTH				0.000	
ALK/TOTAL				51.200	
CHLORIDE				17.000	
CADMIUM				0.006	
CALCIUM				20.300	
CHROMIUM				0.010	
COPPER				0.010	
IRON				0.270	
LEAD				0.005	
MAGNESIUM				3.600	
MANGANESE				0.160	
NICKEL				0.005	
POTASSIUM				0.730	
SILVER				0.010	
SODIUM				8.500	
ZINC				0.020	
AMMONIA				0.020	
NITRATE				2.800	
TKN				3.200	
TOT/P				0.110	
O&G				2.000	
PHENOL				0.001	
PH				7.800	
CO2				6.000	
DO				13.000	
BOD				5.100	
COD				7.700	
SOLIDS/TOT				128.600	
SOLIDS/SUS				19.600	
SOLIDS/DIS				109.000	
CONDUCT				160.000	
* FECAL/COL				4.000	
* TOTAL/COL				360.000	
* FEC/STREP				550.000	
TOTAL/H				57.200	
PRECIPITATION				DRY	

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 4

	Mean / Geometric Mean	Standard Deviation
COLOR/APP	86.000	
COLOR/TRUE	24.000	
TURBIDITY	6.300	
ALK/PHTH	0.000	
ALK/TOTAL	51.200	
CHLORIDE	17.000	
CADMIUM	0.006	
CALCIUM	20.300	
CHROMIUM	0.010	
COPPER	0.010	
IRON	0.270	
LEAD	0.005	
MAGNESIUM	3.600	
MANGANESE	0.160	
NICKEL	0.005	
POTASSIUM	0.730	
SILVER	0.010	
SODIUM	8.500	
ZINC	0.020	
AMMONIA	0.020	
NITRATE	2.800	
TKN	3.200	
TOT/P	0.110	
O&G	2.000	
PHENOL	0.001	
PH	7.800	
CO2	6.000	
DO	13.000	
BOD	5.100	
COD	7.700	
SOLIDS/TOT	128.600	
SOLIDS/SUS	19.600	
SOLIDS/DIS	109.000	
CONDUCT	160.000	
* FECAL/COL	4.000	
* TOTAL/COL	360.000	
* FEC/STREP	550.000	
TOTAL/H PRECIPITATION	57.200	

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 5

Date of Sampling	8/10/79	9/3/79	9/6/79	4/23/80	5/8/80
Analysis Number	2083	2032	2033	2215	2220
TEMP					13.000
COLOR/APP					34.000
COLOR/TRUE					11.000
TURBIDITY					3.600
ALK/PHTH					0.000
ALK/TOTAL					79.700
CHLORIDE					22.500
CADMIUM					0.006
CALCIUM					51.600
CHROMIUM					0.010
COPPER					0.030
IRON					0.750
LEAD					0.030
MAGNESIUM					4.800
MANGANESE					0.240
NICKEL					0.007
POTASSIUM					1.100
SILVER					0.010
SODIUM					12.600
ZINC					0.020
AMMONIA					0.130
NITRATE					0.220
TKN					5.500
TOT/P					0.030
O&G					2.000
PHENOL					0.001
PH					6.300
CO2					12.000
DO					6.000
BOD					6.090
SOLIDS/TOT					164.600
SOLIDS/SUS					15.600
SOLIDS/DIS					149.000
CONDUCT					249.000
* FECAL/COL					1680.000
* TOTAL/COL					22500.000
* FEC/STREP					1240.000
PRECIPITATION					DRY

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean

PROJECT: NORTH HAVEN MALL
Type of Sample: SURFACE WATER
Sampling Location Number: 5

	Mean / Geometric Mean	Standard Deviation
TEMP	13.000	
COLOR/APP	34.000	
COLOR/TRUE	11.000	
TURBIDITY	3.600	
ALK/PHTH	0.000	
ALK/TOTAL	79.700	
CHLORIDE	22.500	
CADMIUM	0.006	
CALCIUM	51.600	
CHROMIUM	0.010	
COPPER	0.030	
IRON	0.750	
LEAD	0.030	
MAGNESIUM	4.800	
MANGANESE	0.240	
NICKEL	0.007	
POTASSIUM	1.100	
SILVER	0.010	
SODIUM	12.600	
ZINC	0.020	
AMMONIA	0.130	
NITRATE	0.220	
TKN	5.500	
TOT/P	0.030	
O&G	2.000	
PHENOL	0.001	
PH	6.300	
CO2	12.000	
DO	6.000	
BOD	6.090	
SOLIDS/TOT	164.600	
SOLIDS/SUS	15.600	
SOLIDS/DIS	149.000	
CONDUCT	249.000	
* FECAL/COL	1680.000	
* TOTAL/COL	22500.000	
* FEC/STREP	1240.000	
PRECIPITATION		

All concentrations in milligrams per litre (mg/l) except Mercury which is in micrograms per litre (ug/l)
* Geometric Mean